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USATECOM PROJECT NO. 4-4-1601-06

4-6-0250-01

USAAVNTA PROJECT NO. 65-37

65-41

AD 834 574

ENGINEERING FLIGHT TEST
(PRODUCT IMPROVEMENT TEST)
OF PRODUCTION OH-6A HELICOPTER
UNARMED AND ARMED WITH THE XM-27E1 WEAPON SYSTEM

PHASE D

FINAL REPORT

DDC FILE COPY

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PROJECT ENGINEER

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PROJECT PILOT

HERMAN P. WOLF
ENGINEER

MARCH 1968

US ARMY AVIATION TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

Statement 4. Controlling office is Army Materiel Command, attn: AMCPM-LH, Washington, D.C. 20315. Per telecons with Mr. W. Goddard (USATECOM) and Col. N.A. Mahone (Project Manager, CAYUSE). A Healy
2 July 1968

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4-4-0250-01
14 USAAVNTA [redacted]-65-37,
USAAVNTA-65-41

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10

JOHN I./NAGATA, — [redacted]ER

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HERMAN P./WOLF — ENGINEER

11 MAR[redacted] [redacted]68 — 12 80p.

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US ARMY AVIATION TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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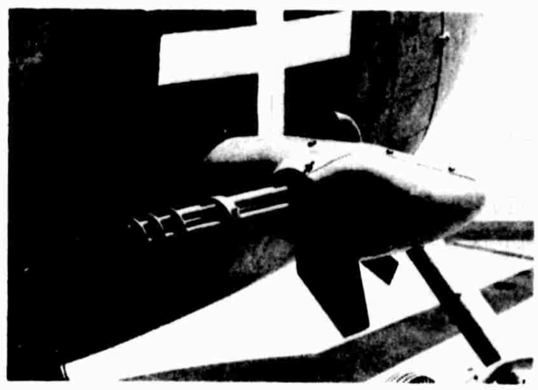


ABSTRACT

effects

An engineering flight test of the OH-6A helicopter equipped with the XM-27E1 armament subsystem was conducted at Edwards Air Force Base, California, by the US Army Aviation Test Activity. The objective of the test was to determine what affects the armament subsystem had on the performance and stability and control characteristics as compared with an aircraft without the armament subsystem. The testing consisted of 10.25 productive test hours and was conducted from 2 October 1967 through 24 October 1967. Performance degradation resulted from the drag imposed by the armament subsystem. The specific range at 2400 pounds gross weight decreased by 8 percent. The stability and control characteristics were essentially unchanged by the addition of the armament subsystem. During firing tests, there were no adverse control problems. However, during flight at 12 degrees left sideslip at 105 knots indicated airspeed (KIAS), the upper right windshield imploded. The sideslip angle should be limited to 8 degrees or less at 100 KIAS until the cause of the implosion can be determined. Noise level and vibration tests should be conducted during firing with the "doors off" configuration. The performance data should be incorporated into the operator's manual.

INTRODUCTION

BACKGROUND

1. The XM-27E1 armament subsystem was developed for installation on the OH-6A helicopter. The 7.62 millimeter (mm) automatic gun (GAU-2B/A) is externally installed with the ammunition stored in the aft compartment. The US Army Aviation Test Activity (USAAVNTA) was authorized by the US Army Test and Evaluation Command (USATECOM) to prepare a Test Plan for the Phase "D" testing which included the XM-27E1 firing phase (reference 1, appendix I). A message was received on 29 September 1967 advising USAAVNTA to cease the performance testing at the high altitude test site and to commence the XM-27E1 test (reference 2, appendix I). A safety-of-flight release for testing the XM-27E1 armament subsystem on the OH-6A helicopter was received on 1 August 1967 (reference 3, appendix I). The USAAVNTA submitted an Interim Letter Report on the safety-of-flight release of the XM-27E1 armament subsystem in October 1967 (reference 4, appendix I). All tests were conducted at the limit gross weight of 2400 pounds (reference 5, appendix I).

TEST OBJECTIVE

2. The objective of the test with the XM-27E1 armament subsystem installed was to determine what effect the subsystem had on the performance and stability and control characteristics during the firing and non-firing phase as compared with an aircraft without the armament subsystem. The pattern of the ejected shell casings and links was also determined.

DESCRIPTION

3. The OH-6A helicopter has a single, four-bladed, fully articulated main rotor and a two-bladed, teetering, pusher antitorque tail rotor. The cyclic, collective, and pedal controls are conventional and unboosted. Skid-type landing gear with air-oil dampened shock struts are used. Power is provided by a T63-A5 free gas turbine engine derated to 260.0 shaft horsepower (shp) for take-off and 221.0 shp for continuous operation. For a more detailed description of the aircraft refer to reference 4, appendix I. The XM-27E1 armament subsystem major components (figure A) are as follows:

a. The GAU-2B/A high rate 7.62 mm automatic gun capable of firing 2000 or 4000 rounds per minute at 10-degrees elevation or 24-degrees depression.

b. The external fairing assembly which covers the gun and incorporates a ram air duct on top to direct high velocity air into the link ejection chute forces the links to be thrown clear of the aircraft.

c. The associated parts for feeding and storing the 2000 rounds of7.62mm ammunition. (For a more detailed description of the XM-27E1 armament subsystem refer to reference 8, appendix I.)

d. The XM-27E1 optical reflex sight which is synchronized with the movement of the gun.

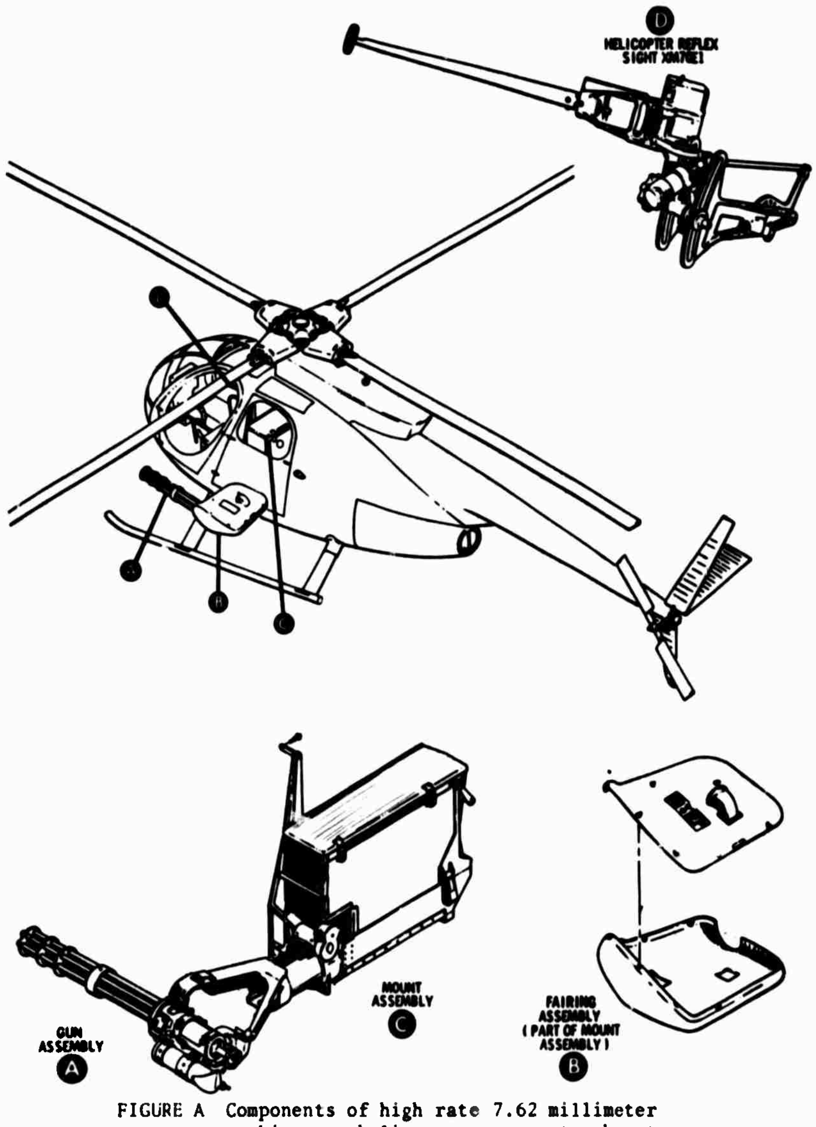


FIGURE A Components of high rate 7.62 millimeter machine gun helicopter armament subsystem XM-27E1 located on OH-6A helicopter.

SCOPE OF TESTS

4. Testing of the XM-27E1 armament subsystem installed on the OH-6A helicopter was conducted at Edwards Air Force Base and Bakersfield, California, during the period 2 October through 24 October 1967. A total of 10.25 flight hours of productive test time was accomplished. The major portion of this flight time was devoted to the level flight performance and to the firing phase. Limited testing was conducted on the nonfiring stability and control tests.

METHODS OF TESTS

5. The test methods and procedures used during the program may be obtained from reference 1, appendix I.

CHRONOLOGY

6. The chronology of testing is outlined as follows:

Aircraft received	27 June 1967
Armament subsystem received	1 August 1967
Flight test started	2 October 1967
Flight test completed	24 October 1967
Draft report submitted	31 December 1967
Final report forwarded	March 1968

RESULTS AND DISCUSSION

GENERAL

7. Level flight performance tests were conducted at gross weights ranging from 2080 pounds to 2710 pounds, rotor speed of 483 rpm, and density altitudes ranging from 5000 to 10,000 feet. All tests were conducted at an average forward center-of-gravity (C.G.) of 97.0 inches with the automatic gun in the stowed position. The armament subsystem installation resulted in an 8 percent decrease in specific range for a gross weight of 2400 pounds, density altitude of 5000 feet, 483 rpm, and an average C.G. of 97.0 inches. No significant differences were noted in the stability and control characteristics of the armed aircraft as compared with those of the clean aircraft. Sideward and rearward flight characteristics were evaluated in-ground-effect (IGE) at the same configuration as the stability and control tests. Comparison of the armed aircraft with the clean aircraft shows no major changes.

8. Firing tests were conducted at an average C.G. of 97.0 inches, gross weight of 2400 pounds, and 483 rpm. A total of 12,670 rounds was expended during firing from hover flight to limit airspeed, sideward and rearward flight, transitions, sideslips, partial power descents, and banking-descending turns. The gun was fired at the high rate of fire (4000 rounds per minute) during maximum elevation of 10 degrees and maximum depression of 24 degrees. No stability or control problems were encountered during firing. At a sideslip angle of 12 degrees at 105 KIAS, the upper right windshield imploded; this terminated further testing. It is recommended that a sideslip angle of 8 degrees or less at 100 KIAS be established until sufficient data can be obtained on the cause of the windshield failure. Qualitatively, the noise level with "doors on" was excessive. Vibrational and additional noise level surveys should be conducted during firing with the aircraft in the "doors off" configuration. These surveys should include tests for possible material failure due to the vibration or recoil created during firing.

LEVEL FLIGHT PERFORMANCE

9. Installation of the XM-27E1 armament subsystem resulted in an increase in power required at the airspeed for 0.99 nautical air miles per pound of fuel (NAMPP) or Airspeed Limit (V_{NE}). An average of 10 percent increase in shp was required as compared

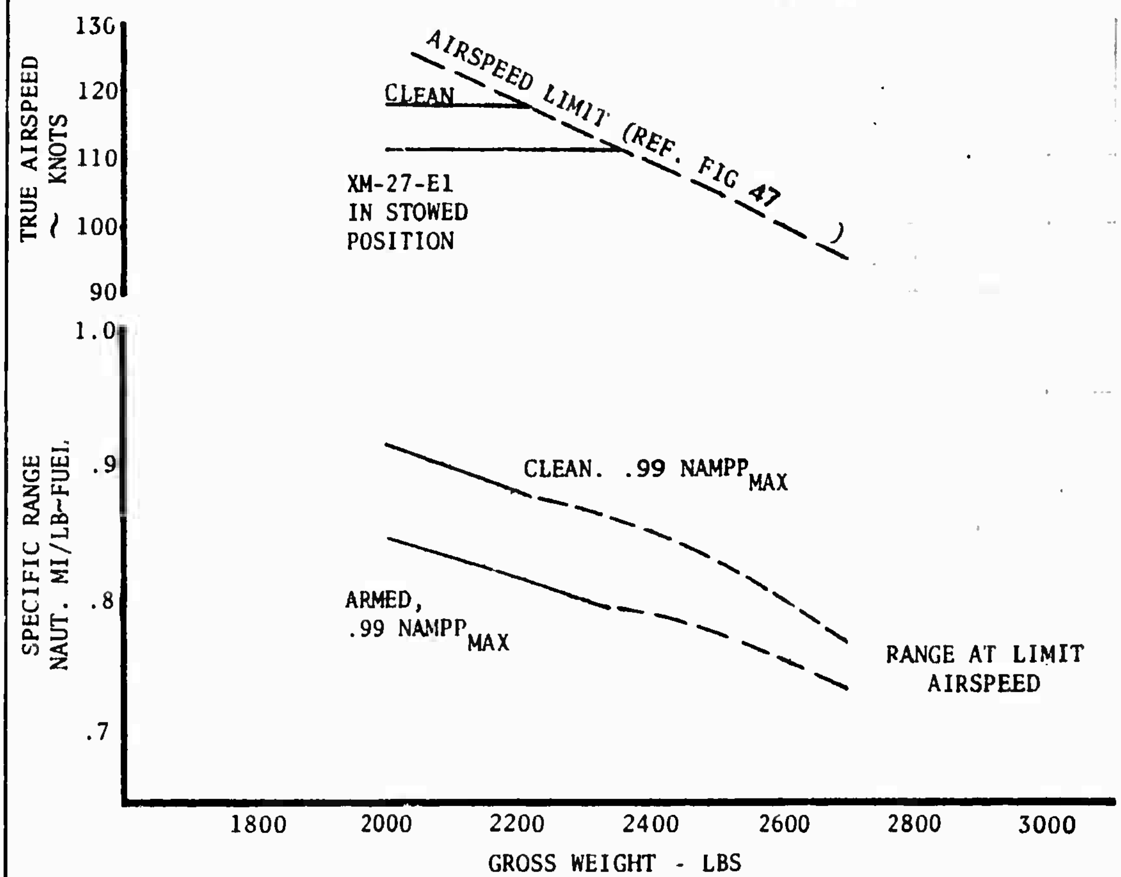
with the unarmed aircraft (figures 6 through 11, appendix II). The power differential is essentially constant at 0.99 NAMPP or limit airspeed.

10. The specific range for a gross weight of 2400 pounds decreased by 8 percent (figure B). The armament subsystem also caused a slight decrease in the endurance performance. The performance data should be incorporated into the Operator's Manual.

FIGURE B
RANGE PERFORMANCE
OH-6A S/N 65-12919

DENSITY ALTITUDE = 5000 FT
ROTOR SPEED = 483 RPM

NOTE:
1. Armed data obtained using Aircraft S/N 65-12919
2. Curves derived from Figures 1 through 5 and 44



STATIC LONGITUDINAL COLLECTIVE-FIXED STABILITY

11. The collective-fixed static longitudinal stability was similar to the stability of the clean aircraft except for 1 inch of right lateral stick displacement required to compensate for the left lateral C.G. due to the installation of the armament subsystem. The weapon installation also created a slight increase in longitudinal control stability with increasing airspeed (figure 12, appendix II). This positive control position is in accordance with MIL-H-8501A, paragraph 3.2.10 (reference 12, appendix I). The remaining control margin was sufficient to produce 10 percent of the maximum attainable pitching moment as required in MIL-H-8501A, paragraph 3.2.1 (Pilot Rating Scale (PRS) A-2, appendix III).

STATIC LATERAL-DIRECTIONAL STABILITY

12. The static lateral-directional stability was essentially unchanged with the armament subsystem installed as compared to the clean aircraft. Both configurations show a positive dihedral effect for all airspeeds. The static lateral-directional stability of the aircraft increases with airspeed (figure 16, appendix II).

13. The variation of lateral control displacement and pedal displacement with increasing sideslip does not meet the linear variation requirement of MIL-H-8501A, paragraph 3.3.9. However, this condition was not objectionable to the pilot. A 10 percent margin of both the lateral and longitudinal control effectiveness remains as required in MIL-H-8501A, paragraph 3.3.9 (PRS A-3, appendix III).

DYNAMIC STABILITY

14. The dynamic stability characteristics of the armed aircraft were essentially unchanged as compared with those of the clean aircraft. The resulting oscillation created by longitudinal or lateral pulse inputs damped to one-half amplitude in less than 2 cycles with a period of less than 5 seconds.

15. The directional control pulse input created a roll-yaw coupling effect which damped in less than 2 cycles with a period of less than 5 seconds (figures 17 through 19, appendix II) (PRS A-3, appendix III).

CONTROLLABILITY

16. Controllability tests on the armed aircraft indicate that the control response and control sensitivity are greater about all

three axes than those of the clean aircraft (figures 20 and 27, appendix II). Qualitatively, the controllability of the armed aircraft as compared to that of the clean aircraft was similar about all three axes (PRS A-2, appendix III).

SIDEWARD AND REARWARD FLIGHT

17. Sideward and rearward flight comparison between the armed and clean aircraft shows that during sideward flight to the left with the clean aircraft the longitudinal cyclic stick moves aft with increasing airspeed (figure 33, appendix II). During the same test with the armed aircraft, the longitudinal cyclic stick had a reversal at 20 knots true airspeed (KTAS) (figure 34, appendix II). This reversal was not readily apparent to the pilot. Sideward flight to the right was essentially the same as that of the clean aircraft. Comparison of the two configurations during rearward flight shows no major differences (figures 35 and 36, appendix II).

18. Military Specification MIL-H-8501A required a left and right sideward airspeed of 35 knots and a rearward airspeed of 30 knots. At the deviation airspeeds of 20 knots, adequate control margin existed to produce 10 percent of the maximum attainable rolling as required by MIL-H-8501A, paragraphs 3.2.1, 3.3.2, and 3.3.4 (PRS A-4, appendix III).

XM-27E1 FIRING

19. Firing tests were conducted during the following flight conditions:

a. Hovering (IGE and OGE).

b. Transition from hover to forward flight and from forward flight to hover.

c. Level flight at 85 KIAS and 15 degrees left and right sideslip angle and 105 KIAS and 12-degrees left and right sideslip angle.

d. Sideward flight (left and right).

e. Rearward flight.

f. Partial power descent (65 KIAS and 700 feet per minute (fpm) rate of descent (R/D).

g. Thirty-degrees, 45-degrees, and 60-degrees bank during 90-degrees descending turn as stated in reference 4, appendix I.

During the above conditions, the gun was fired in the "up" position (10 degrees) or "down" position (24 degrees) using the high rate of fire (4000 rounds per minute).

20. No adverse stability and control problems were encountered when firing the gun at maximum azimuth conditions. The slight pitch or yaw excursions caused by the gun's firing were easily controlled by the pilot (PRS A-4, appendix III).

21. During the firing tests, approximately 12,670 rounds of 7.62 mm ammunition were expended. Testing was stopped five times due to the following:

a. Broken shear pin in the feed mechanism (2 delays).

b. Rotor overspeed.

c. Implosion of upper right windshield.

d. Faulty connector.

22. The firing phase of the test program was terminated due to the upper windshield failure during the 12-degree left sideslip test. Until sufficient data can be obtained on the windshield implosion, the maximum sideslip should be less than 8 degrees at 100 KIAS (reference 6, appendix I). Data during autorotation and low speed slideslip conditions were not obtained due to termination of testing. However, based on similar tests flown and contractor data, indications are that no safety-of-flight conditions should be encountered, and it is recommended that these tests not be conducted.

23. Vibration during firing was not evaluated due to unavailability of test equipment. Tests should be conducted to determine the vibration level recoil effect during firing on the aircraft with the "doors off" configuration (reference 6, appendix I).

24. Noise level measurements were not obtained during the tests. However, the US Army Aeromedical Research Unit (USAARU) made a survey and found the noise level to be excessive. The report has not been published as of this date. Appropriate protection measurements, such as use of ear plugs, should be taken by personnel firing the gun (reference 4, appendix I).

25. Time histories of the control displacements during firing show that large control inputs were not required to maintain heading or attitude of the aircraft (figures 37 through 41, appendix II).

26. The items found to be incompatible with the aircraft during the firing tests are as follows:

a. The control button on the cyclic for moving the gun "up" for elevation and "down" for depression is reversed.

b. The exact position of the weapon was impossible to determine from the pilot's seat.

c. The present "fire-to-clear" warning indicator light is confusing and misleading. The "fire-to-clear" procedure is to remove the ammunition from the vicinity of the barrel to prevent the accidental discharge of the rounds.

d. The locking device on the main power source cannon plug was loosened by the firing test vibration.

27. The present system of having ram air force the links away from the aircraft is excellent. Motion pictures of the spent shell casings and links show that the flow pattern is well away from the aircraft and tail rotor. Occasionally the links were observed to be heading toward the tail rotor; however, there were no strikes on the test aircraft's tail rotor.

28. Qualitatively, there were no safety-of-flight areas encountered during the flight profiles. The 60-degree bank, 90-degree descending turn was uncomfortable, and blade stall or rotor overspeed could be encountered if considerable pilot attention and judicious use of the collective or longitudinal cyclic controls are not observed during recovery from the maneuver (PRS A-3, appendix III).

STANDARD AIRSPEED SYSTEM

29. Installation of the gun did not affect the standard airspeed position error during non-firing tests (figure 42, appendix II). During the firing tests, the gun caused the standard ship airspeed indicator to fluctuate approximately ± 10 knots. However, the fluctuation was not objectionable since it ceased when firing was completed.

Conclusions

30. The installation of the XM-27E1 armament subsystem resulted in a decrease of the level flight performance (para 10).

31. There were negligible changes in the static or dynamic stability characteristics as compared to changes in the unarmed aircraft (para 14).

32. Firing the XM-27E1 armament subsystem can be accomplished with no safety-of-flight problems when the recommended flight envelope is observed. However, firing during 12 degrees of sideslip at 105 KIAS should not be performed until further study on the effects of vibrations on the aircraft's windshields can be accomplished (para 19).

33. Various items of the XM-27E1 armament subsystem were found to be incompatible with the aircraft (para 26).

34. Noise level inside the cockpit during firing was excessive (para 24).

35. Considerable pilot attention and judicious use of the collective or cyclic control stick should be observed during recovery from maneuvering profiles (para 28).

Recommendations

36. The performance data obtained during this evaluation should be incorporated into the OH-6A Operator's Manual (para 10).

37. The maximum sideslip angle should be limited to less than 8 degrees at 100 KIAS until a study can be made on what effect the vibration created by the gun's firing has on the aircraft windshield (para 22).

38. The vibration study should be accomplished with combinations of the "doors off" configuration (para 23).

39. The present weapon subsystem should be changed as follows:

a. Change the control button on the cyclic stick for movement of the gun to "up" for elevation and "down" for depression.

b. Incorporate a visual indicator sight for the exact position of the gun (para 26).

c. Change or modify the "fire-to-clear" warning indicator light.

d. Incorporate a stronger locking device on the main power source cannon plug so that vibration will not shake it loose.

40. Further evaluation of the noise level inside the cockpit during firing should be accomplished. This evaluation should be done on the "doors off" configuration (para 24).

APPENDIX I REFERENCES

1. Plan of Test, USAAVNTA, "Engineering Flight Test, Product Improvement Test (Phase D), of Production OH-6A Helicopter, Unarmed and Armed with XM-27 Weapon Subsystem, "August 1966.

2. Unclassified Message, USAAVCOM, AMSAV-ER - 9-1400, "XM-27E1 Priority Testing," 29 September 1967.

3. Unclassified Message, USAMC, AMC 74062, August 1967, "Safety of Flight Release for Testing of XM-27E1 Armament Kit on OH-6A."

4. Unclassified Message, USAAVNTA, SAVTE-E - 00311, "OH-6A/XM-27E1 Weapon System," 17 October 1967.

5. Unclassified Message, USAAVCOM, 03-14005, March 1967, "Safety of Flight Limit to 2400 Pounds."

6. Unclassified Message, USAAVNTA, SAVTE-E - 24875, 27 October 1967, "OH-6A/XM-27E1 Weapon System."

7. Operator's Manual, TM 55-1520-214-10, Aircraft Division, Hughes Tool Company, "Helicopter Observation OH-6A," January 1967.

8. Operator and Organizational Maintenance Manual, TM 9-1005-298-12, "Armament Subsystem, Helicopter, 7.62 Millimeter Machine Gun: High Rate, XM-27E1," May 1967.

9. Final Report, USAAVNTA, part one of two parts, "Engineering Flight Test Stability and Control Phase of the OH-6A Helicopter, Unarmed (Clean) and Armed with the XM-7 or XM-8 Weapon Subsystem, USATECOM Project No. 4-3-0250-51/52/53," August 1964.

10. Final Report, USAAVNTA, part two of two parts, "Engineering Flight Test Performance Phase of the OH-6A Helicopter, Unarmed (Clean) and Armed with the XM-7 or XM-8 Weapon Subsystem, USATECOM Project No. 4-3-0250-51/52/53," August 1964.

11. Final Report, USAAVNTA, "Continued Engineering Flight Test of the YOH-6A Helicopter, USATECOM Project No. 4-3-0250-78," May 1967.

12. Military Specification MIL-H-8501A, "Helicopter Flying and Ground Handling Qualities; General Requirements For," 7 September 1967.

13. Model Specification No. 580-F, Amendment No. 1, Model T63-A-5A, Allison Division of General Motors, 18 August 1965.

APPENDIX II

TEST DATA

FIGURE NO. 4
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12919
CLEAN CONFIGURATION

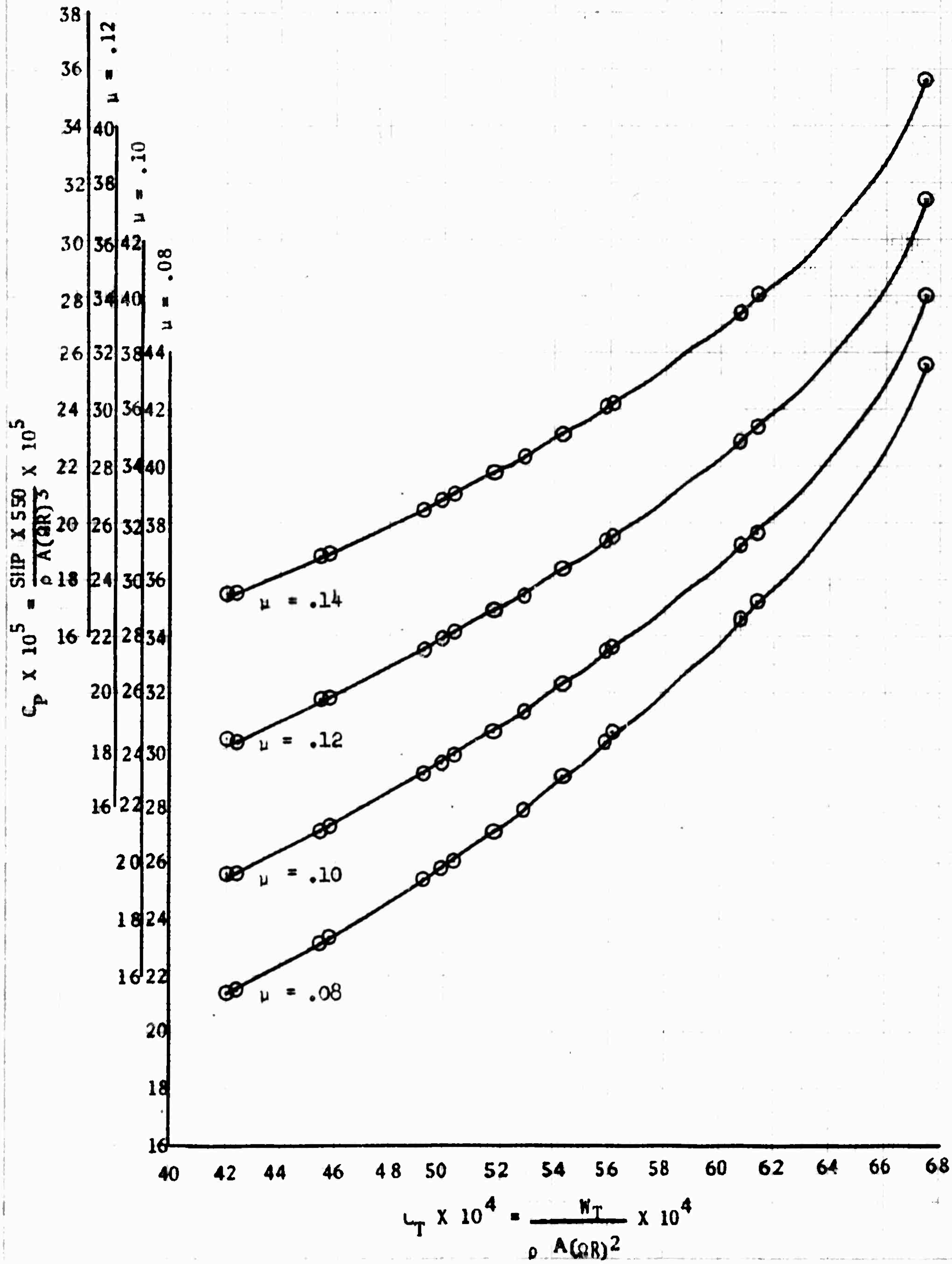


FIGURE NO. 8
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12919
CLEAN CONFIGURATION

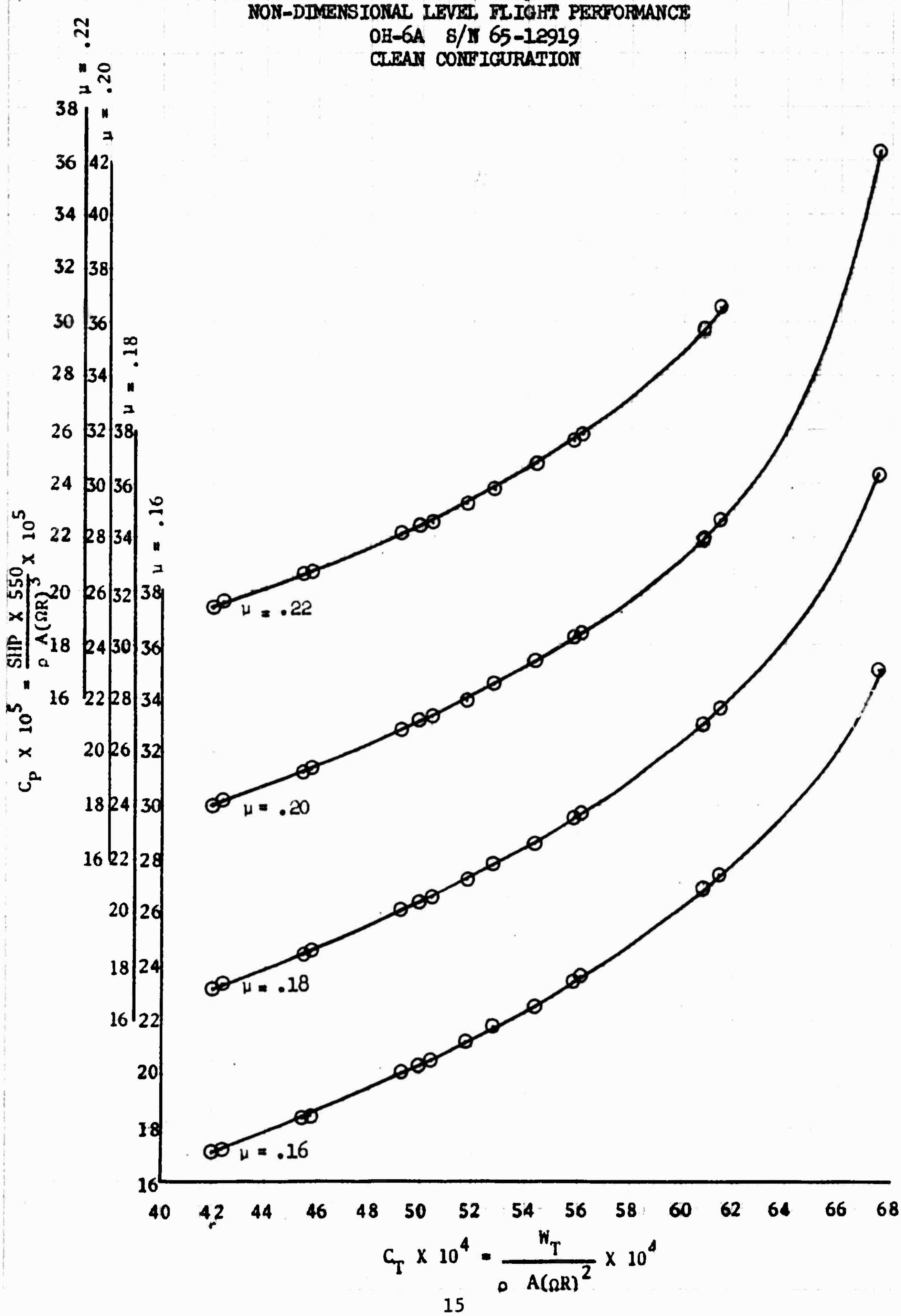


FIGURE NO. 3
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12919
CLEAN CONFIGURATION

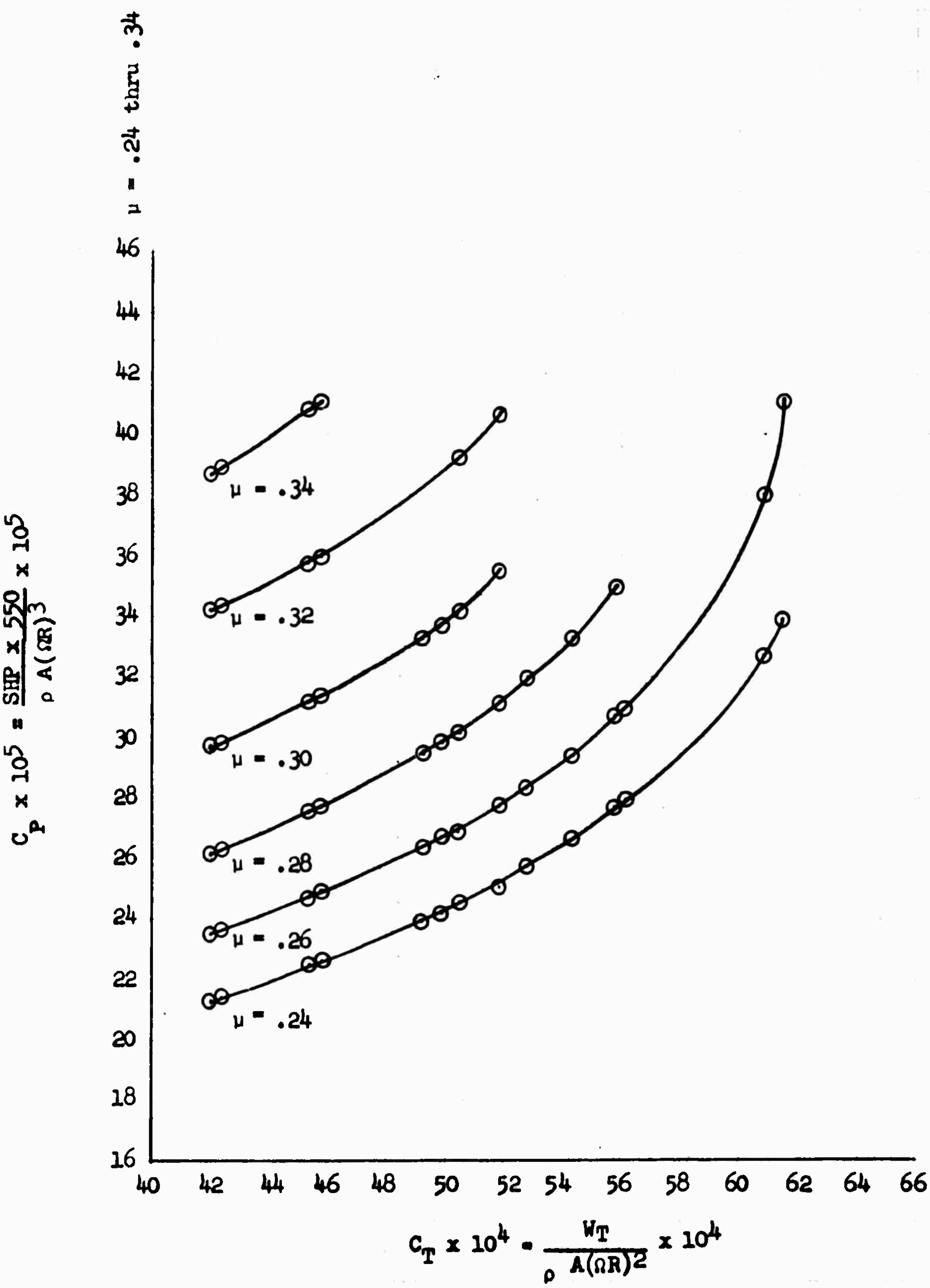


FIGURE NO. 4
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

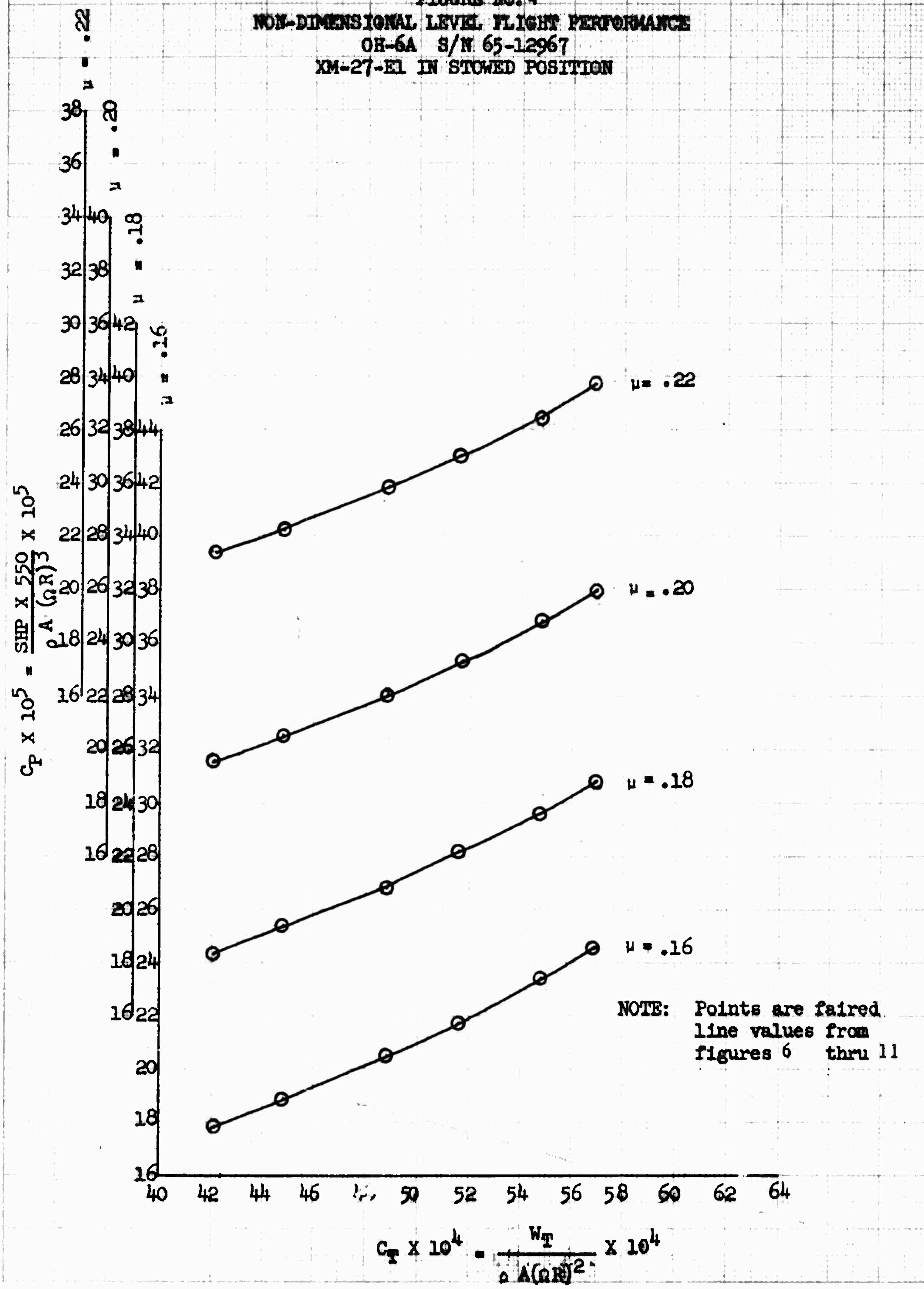
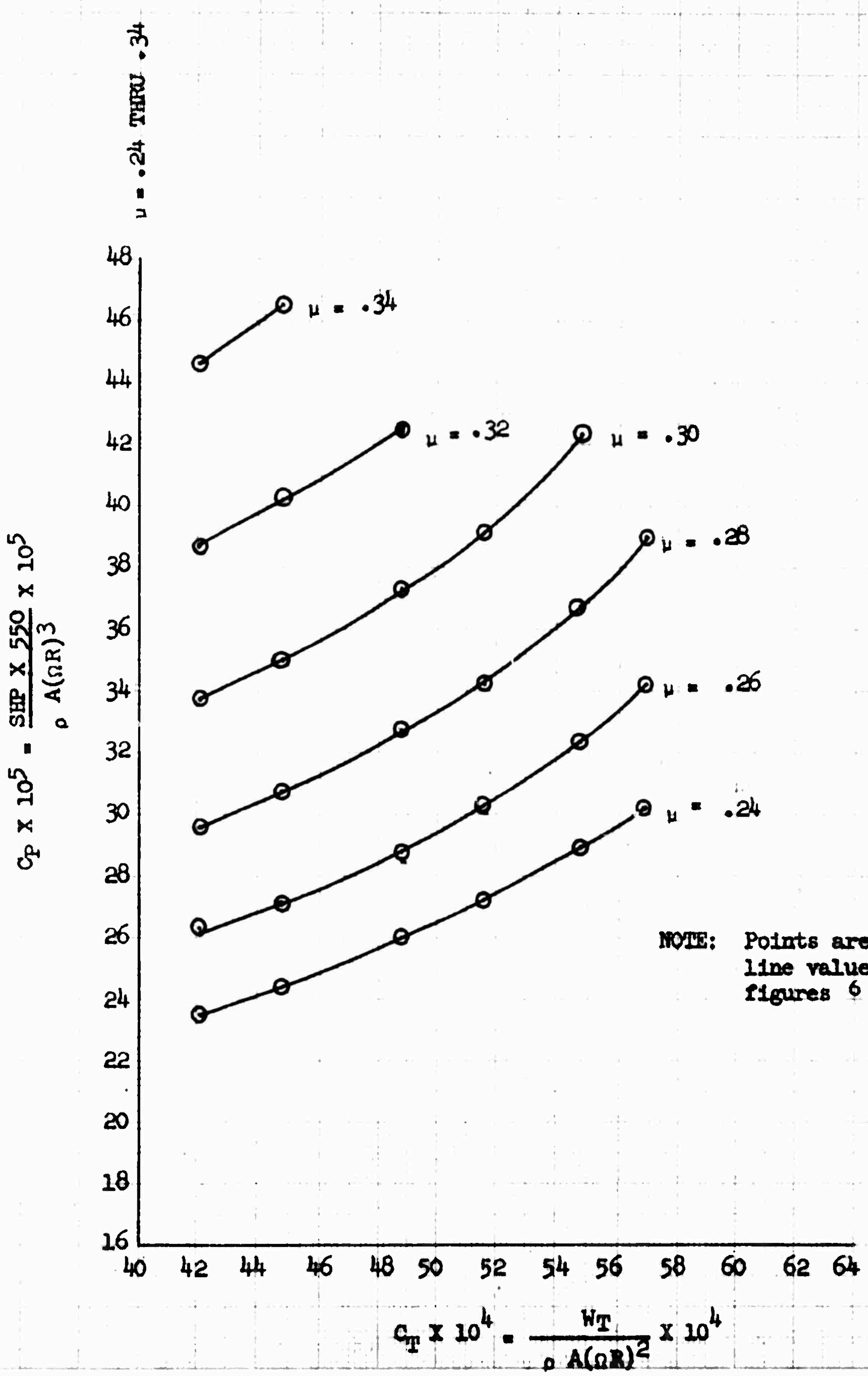


FIGURE NO. 5
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION



NOTE: Points are faired line values from figures 6 thru 11

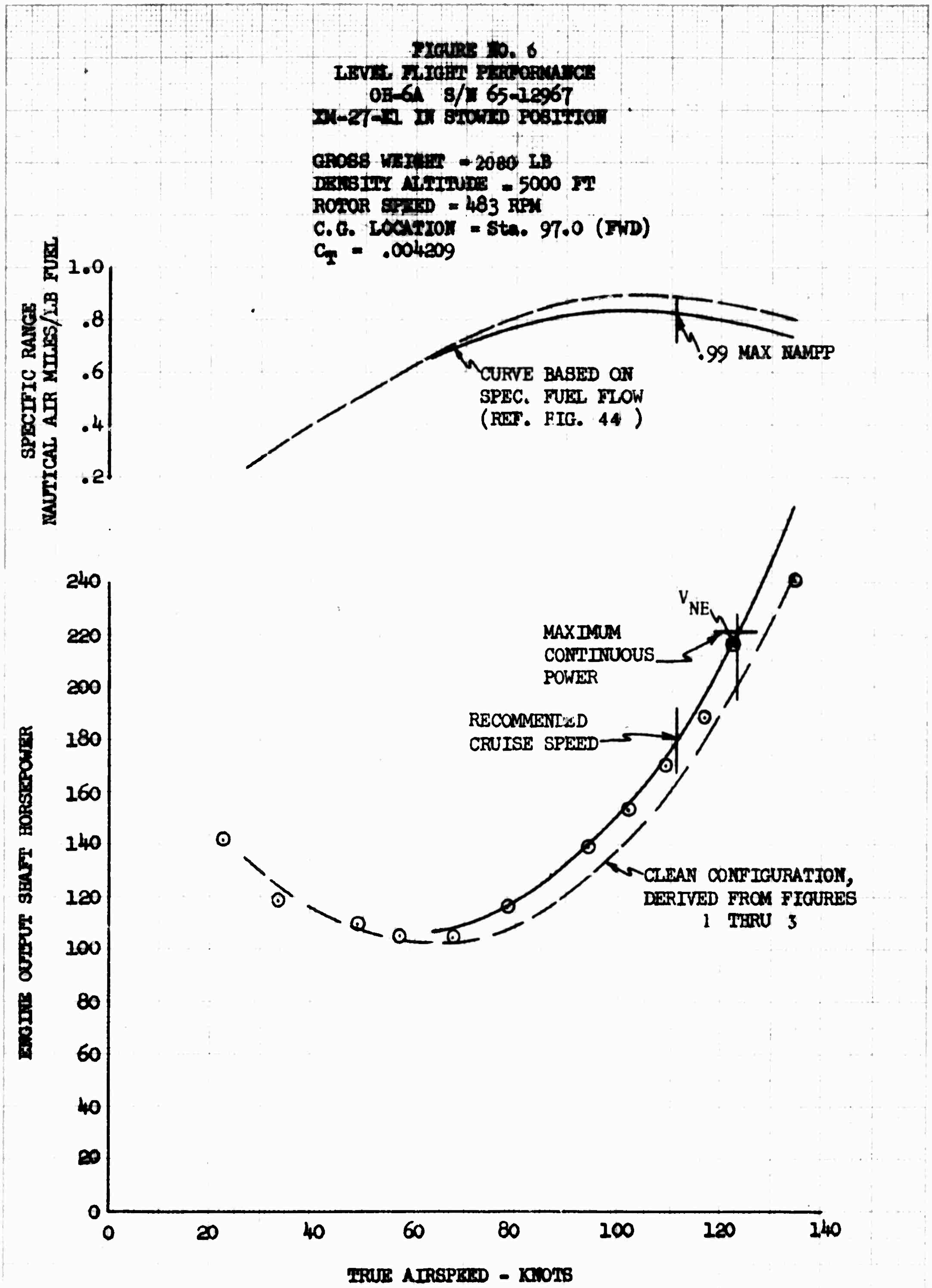
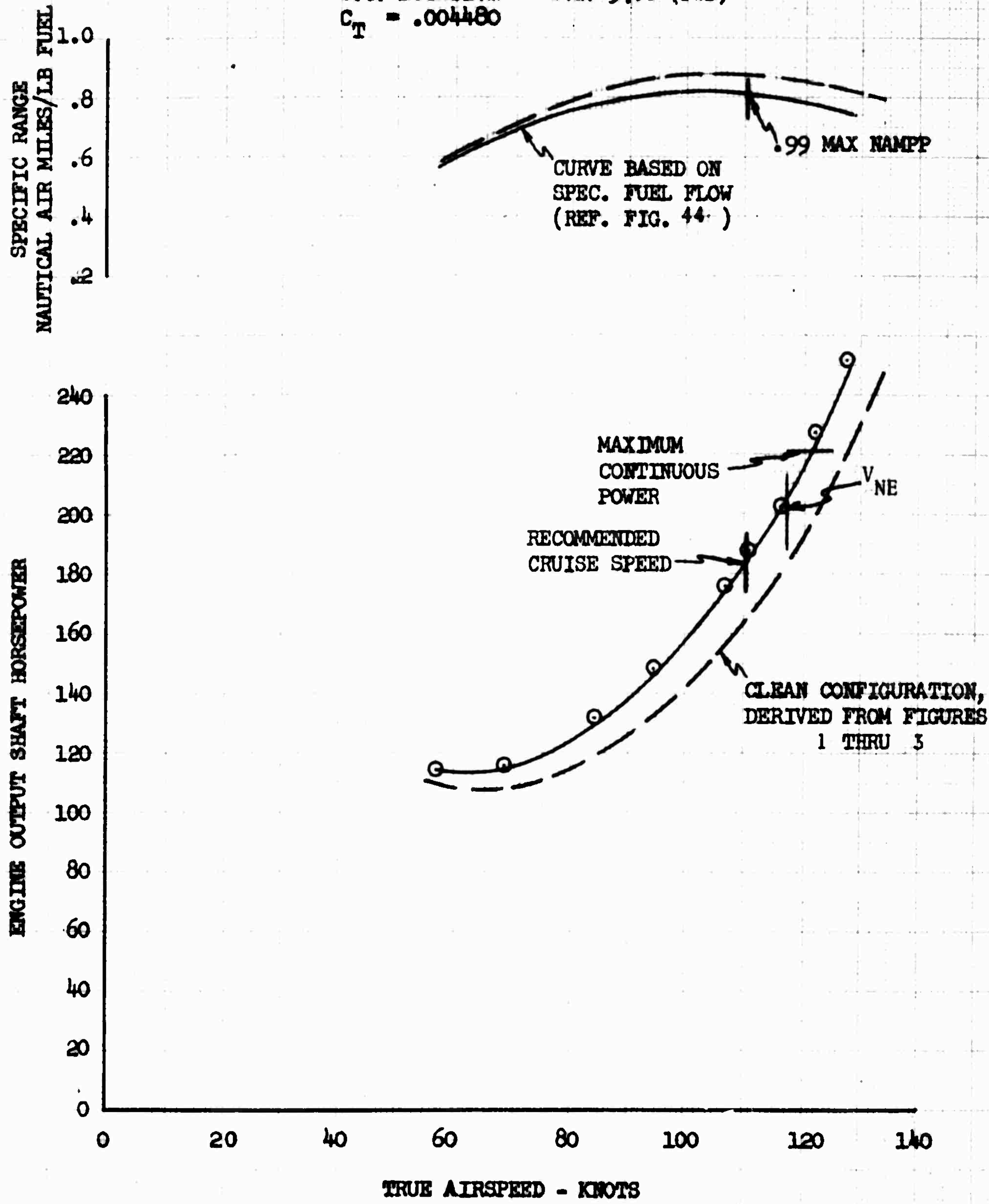


FIGURE NO. 6
LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION
GROSS WEIGHT = 2080 LB
DENSITY ALTITUDE = 5000 FT
ROTOR SPEED = 483 RPM
C.G. LOCATION = Sta. 97.0 (FWD)
C_T = .004209
SPECIFIC RANGE
NAUTICAL AIR MILES/LB FUEL
1.0
.8
.6
.4
.2
.99 MAX NAMPP
CURVE BASED ON
SPEC. FUEL FLOW
(REF. FIG. 44)
ENGINE OUTPUT SHAFT HORSEPOWER
240
220
200
180
160
140
120
100
80
60
40
20
0
V_{NE}
MAXIMUM
CONTINUOUS
POWER
RECOMMENDED
CRUISE SPEED
CLEAN CONFIGURATION,
DERIVED FROM FIGURES
1 THRU 3
0
20
40
60
80
100
120
140
TRUE AIRSPEED - KNOTS

FIGURE NO. 7
LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

GROSS WEIGHT = 22[illegible] LB
DENSITY ALTITUDE = 5000 FT
ROTOR SPEED = 483 RPM
C.G. LOCATION = Sta. 97.0 (FWD)
C_T = .004480



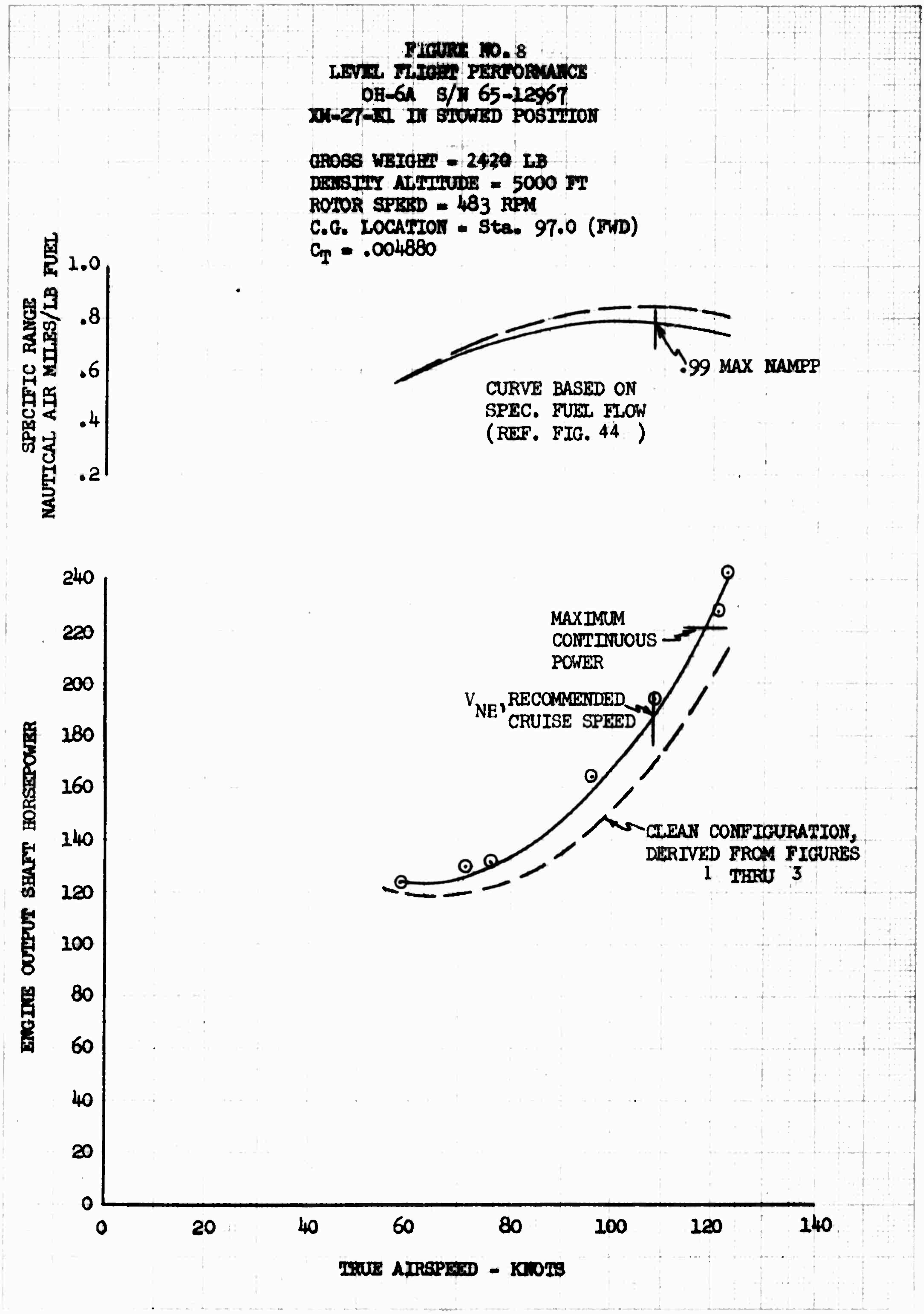


FIGURE NO. 8
LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION
GROSS WEIGHT = 2420 LB
DENSITY ALTITUDE = 5000 FT
ROTOR SPEED = 483 RPM
C.G. LOCATION = Sta. 97.0 (FWD)
C_T = .004880
SPECIFIC RANGE
NAUTICAL AIR MILES/LB FUEL
1.0
.8
.6
.4
.2
.99 MAX NAMPP
CURVE BASED ON
SPEC. FUEL FLOW
(REF. FIG. 44)
ENGINE OUTPUT SHAFT HORSEPOWER
240
220
200
180
160
140
120
100
80
60
40
20
0
MAXIMUM
CONTINUOUS
POWER
V_{NE}, RECOMMENDED
CRUISE SPEED
CLEAN CONFIGURATION,
DERIVED FROM FIGURES
1 THRU 3
0
20
40
60
80
100
120
140
TRUE AIRSPEED - KNOTS

FIGURE NO. 9
LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

GROSS WEIGHT = 2550 LB
DENSITY ALTITUDE = 5000 FT
ROTOR SPEED = 483 RPM
C.G. LOCATION = Sta. 97.2 (FWD)
C_T = .005165

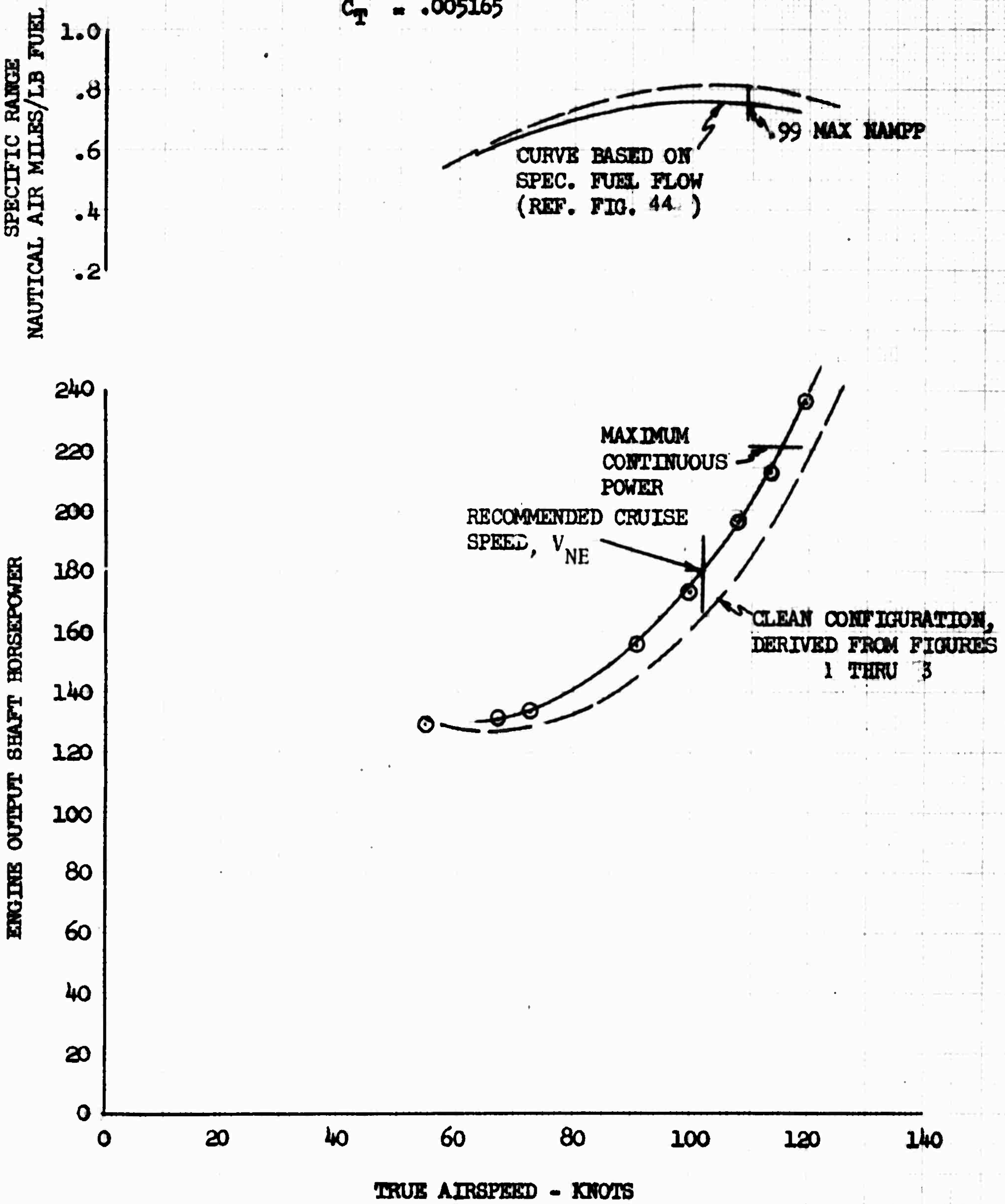
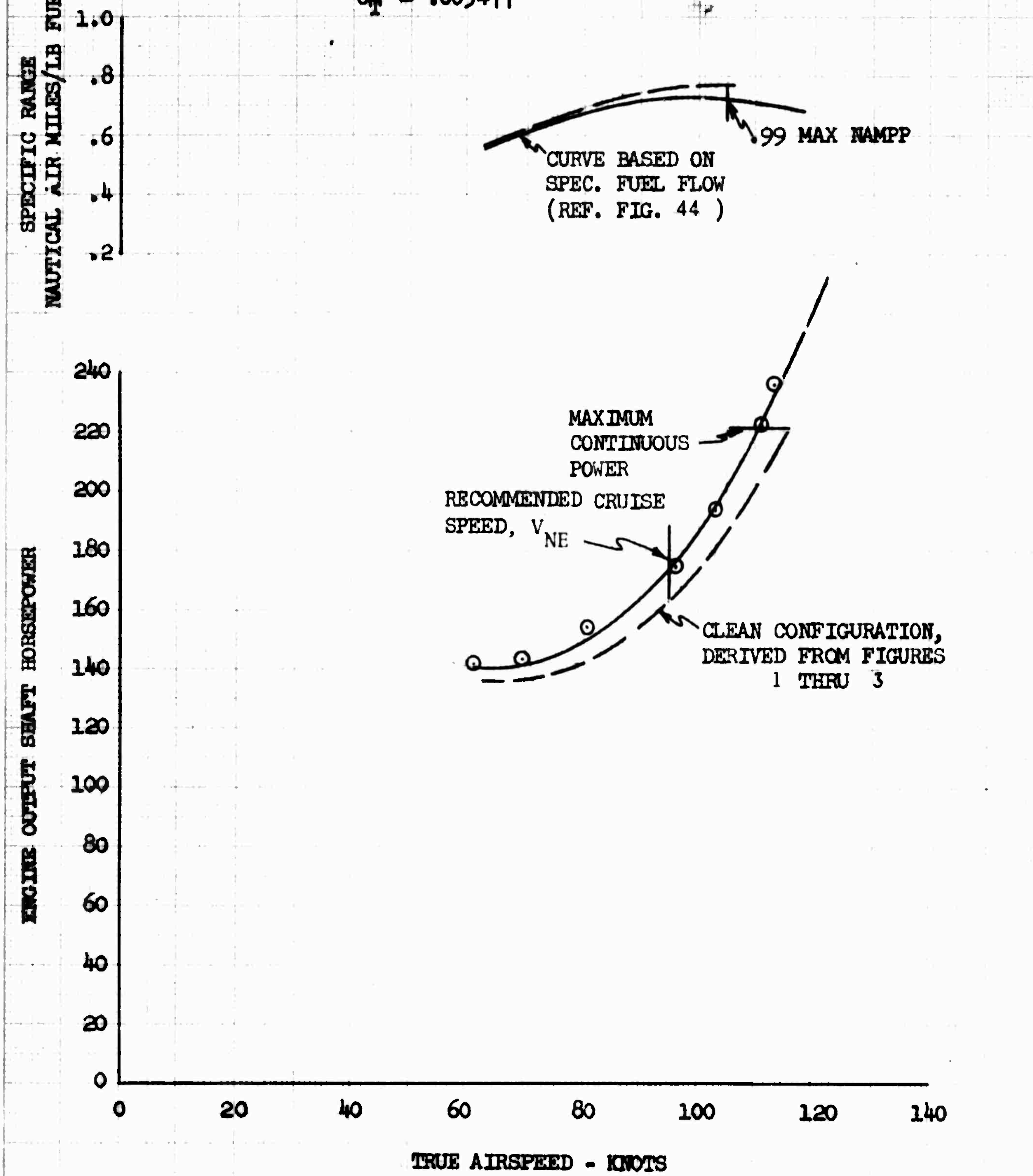


FIGURE NO. 10
LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

GROSS WEIGHT = 2710 LB
DENSITY ALTITUDE = 5000 FT
ROTOR SPEED = 483 RPM
C.G. LOCATION = Sta. 96.9 (FWD)
C_T = .005477



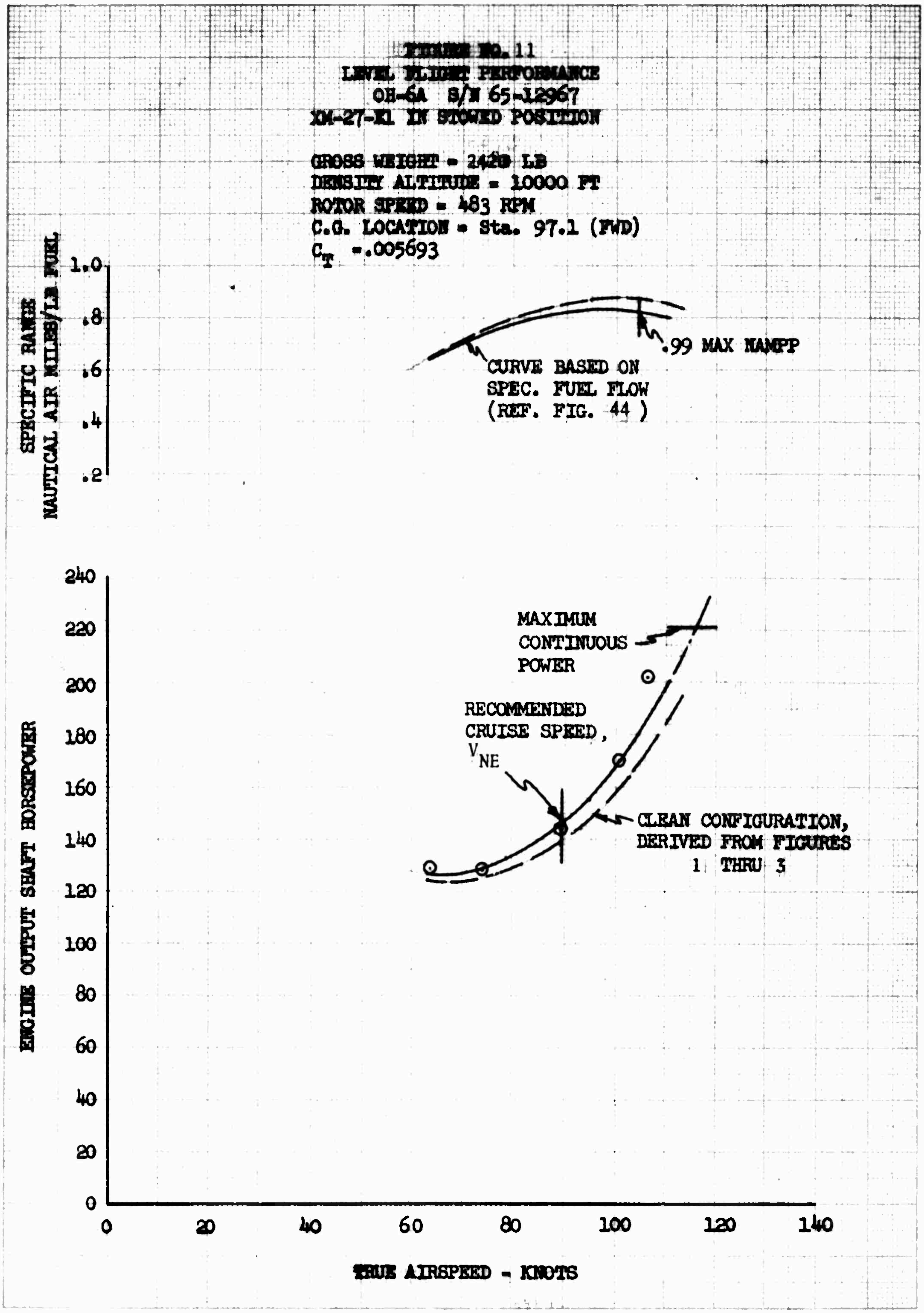


FIGURE NO. 11
LEVEL FLIGHT PERFORMANCE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

GROSS WEIGHT = 2420 LB
DENSITY ALTITUDE = 10000 FT
ROTOR SPEED = 483 RPM
C.G. LOCATION = Sta. 97.1 (FWD)
C_T = .005693

FIGURE NO. 12
CONTROL POSITION TRIM CURVES
OH-6A S/N 65-12919 & 967

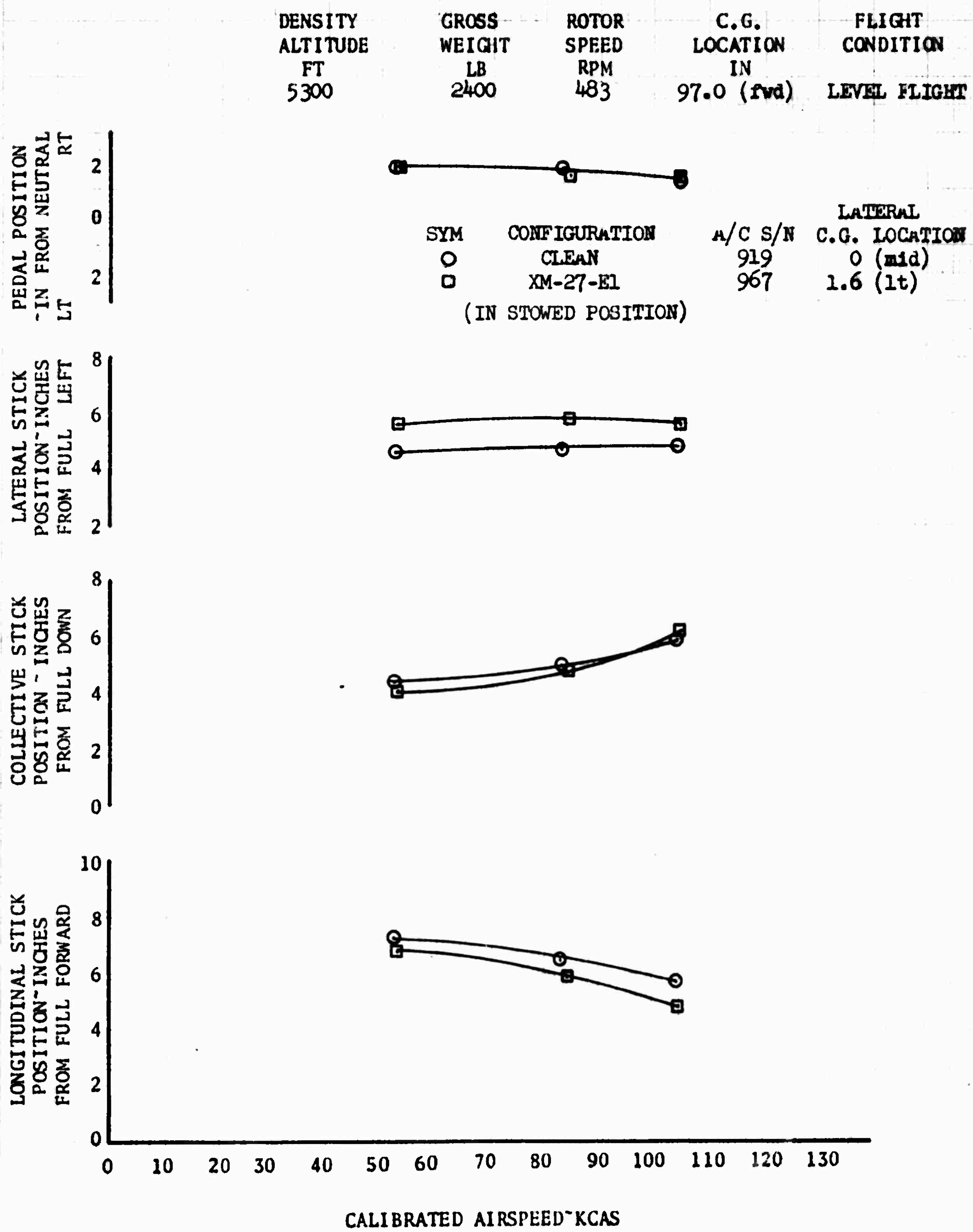
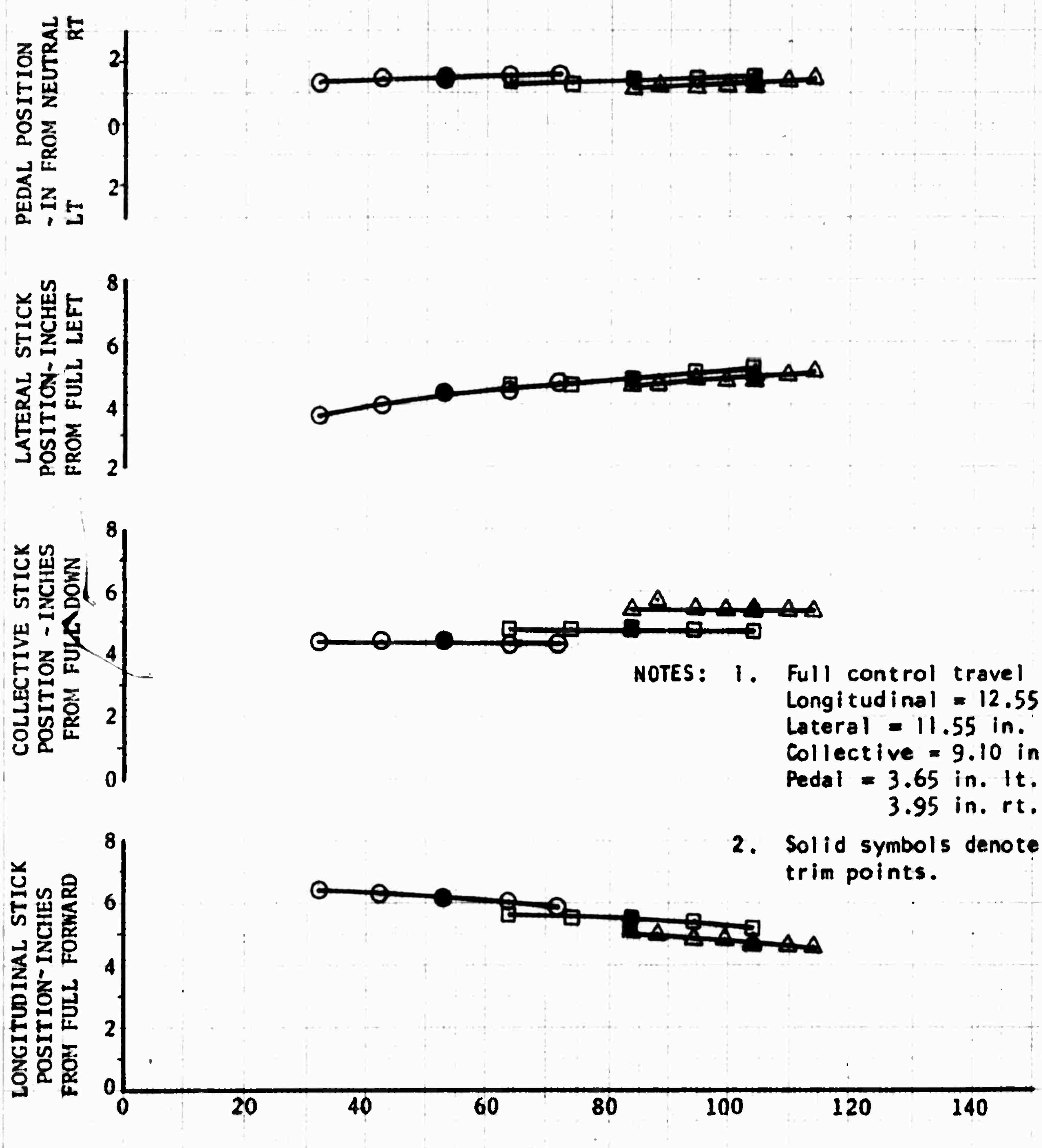


FIGURE NO. 13
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	TRIM AIRSPEED KCAS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	5040	2420	483	103.0(Aft)	Level Flight
□	83.5	5000	2380	483	103.0(Aft)	Level Flight
△	104.0	5040	2400	483	103.0(Aft)	Level Flight

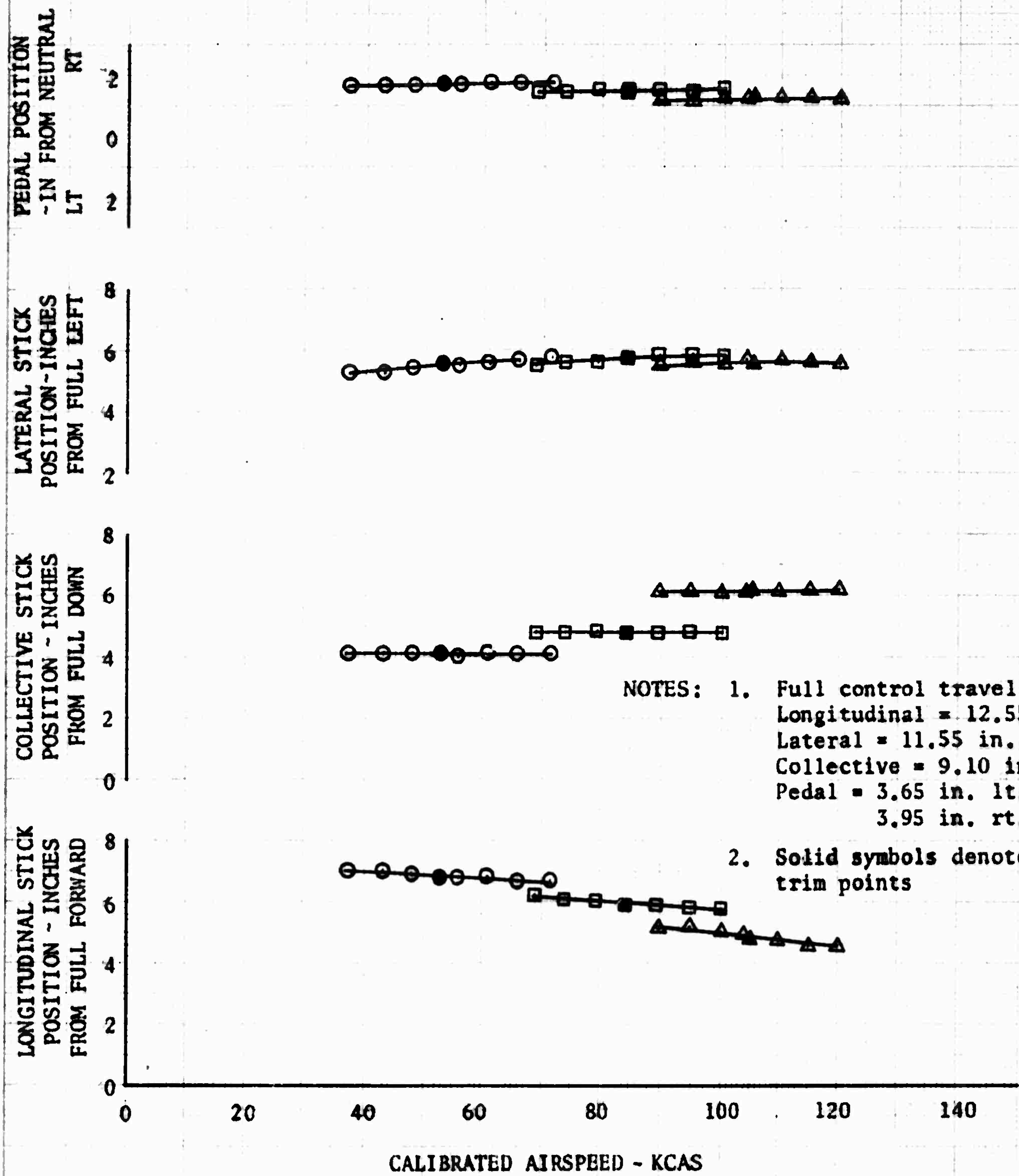


NOTES: 1. Full control travel
Longitudinal = 12.55 in.
Lateral = 11.55 in.
Collective = 9.10 in.
Pedal = 3.65 in. lt.
3.95 in. rt.

2. Solid symbols denote trim points.

FIGURE NO. 14
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

SYM	TRIM AIRSPEED KCAS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG.	C.G. LOCATION IN LAT.	FLIGHT CONDITION
O	53.0	5420	2410	483	97.0 (FWD)	1.6 (LT)	LEVEL FLIGHT
□	84.5	5290	2400	483	97.0 (FWD)	1.6 (LT)	LEVEL FLIGHT
Δ	105.0	5270	2380	483	97.0 (FWD)	1.6 (LT)	LEVEL FLIGHT



NOTES: 1. Full control travel
Longitudinal = 12.55 in.
Lateral = 11.55 in.
Collective = 9.10 in.
Pedal = 3.65 in. lt.
3.95 in. rt.

2. Solid symbols denote trim points

FIGURE NO. 15
STATIC LATERAL-DIRECTIONAL STABILITY
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	TRIM AIRSPEED KCAS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	5120	2410	483	97.2(Fwd)	Level Flight
□	83.5	5080	2360	483	97.2(Fwd)	Level Flight
△	105.0	5220	2330	483	97.2(Fwd)	Level Flight

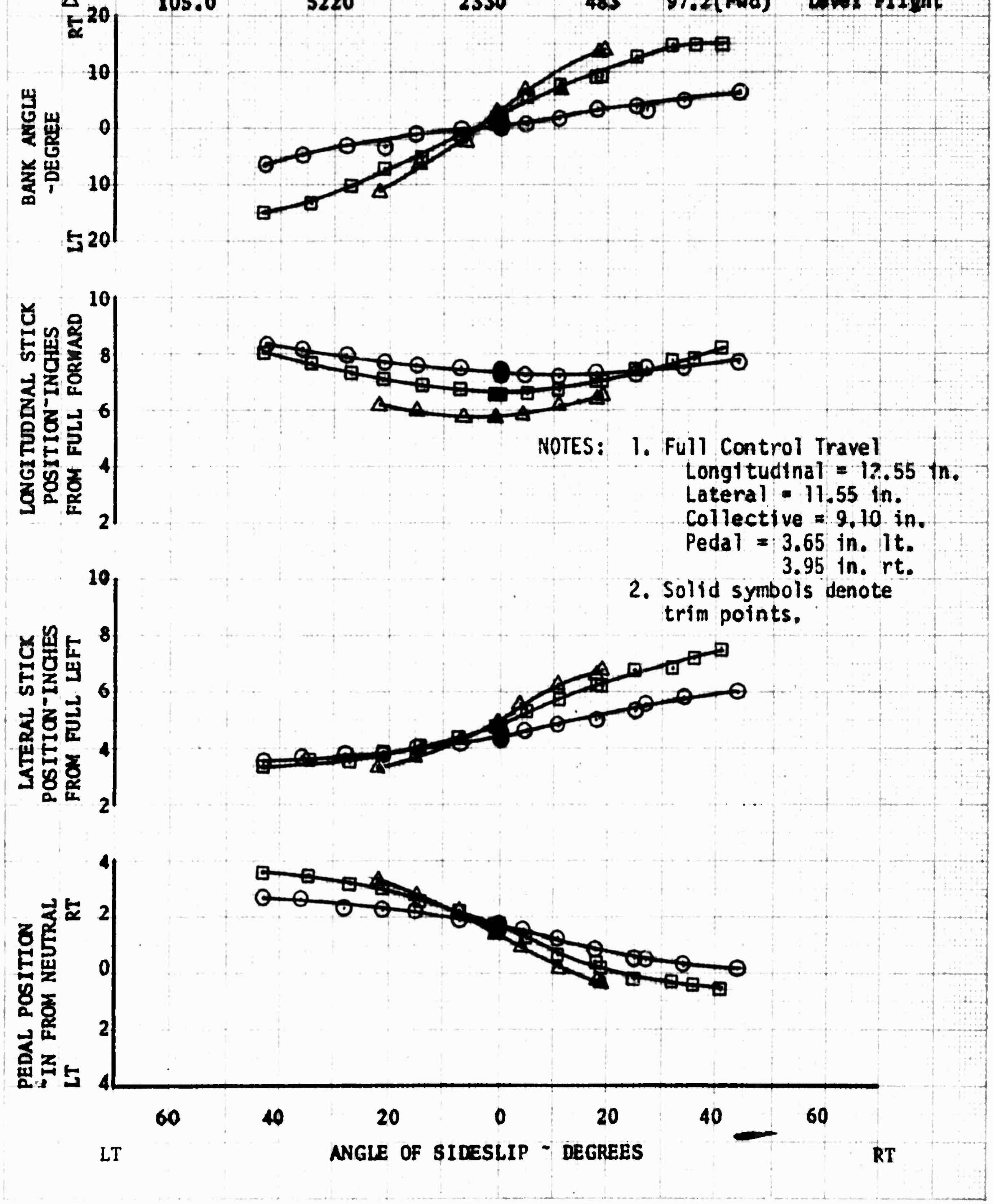


FIGURE NO. 16
STATIC LATERAL-DIRECTIONAL STABILITY
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

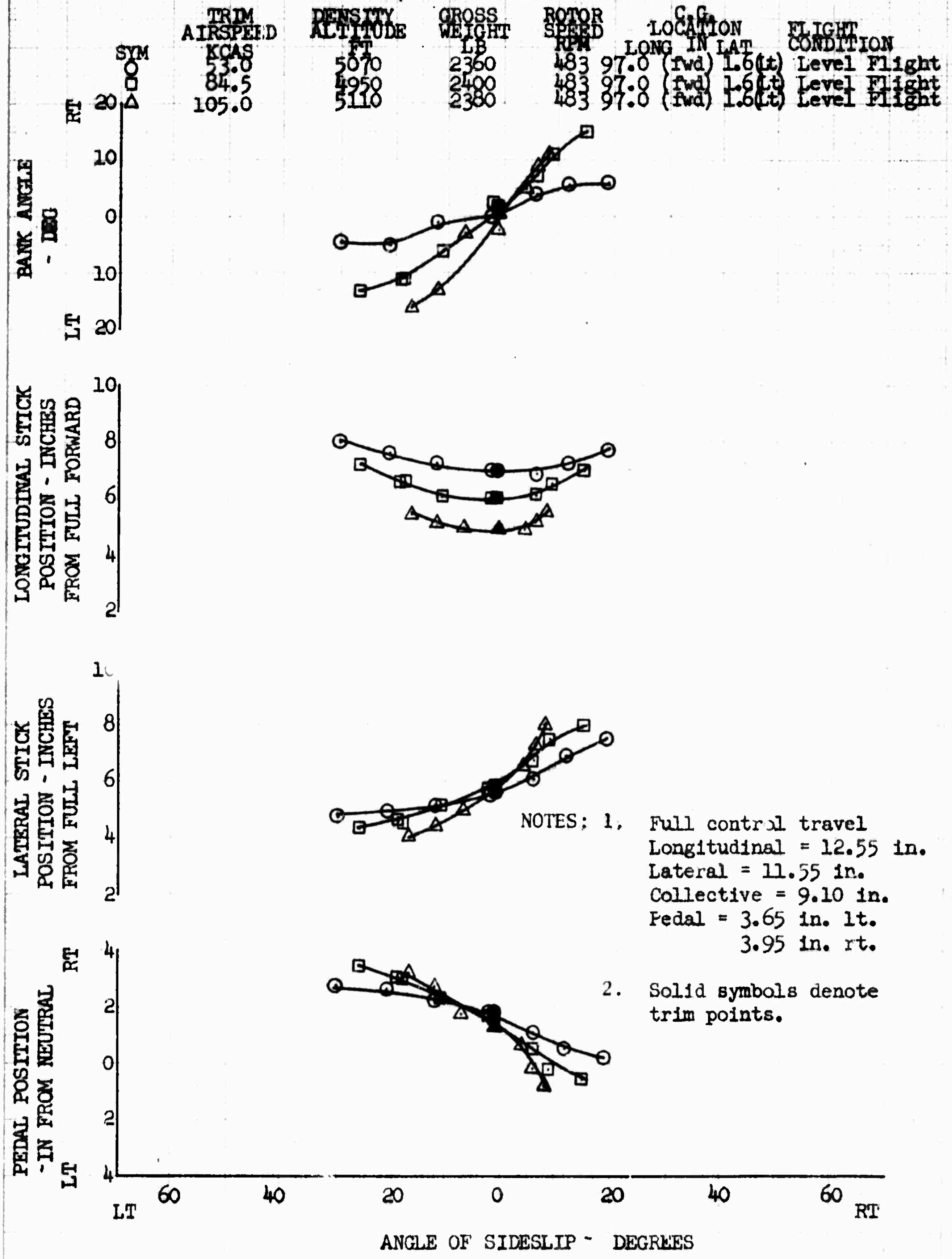
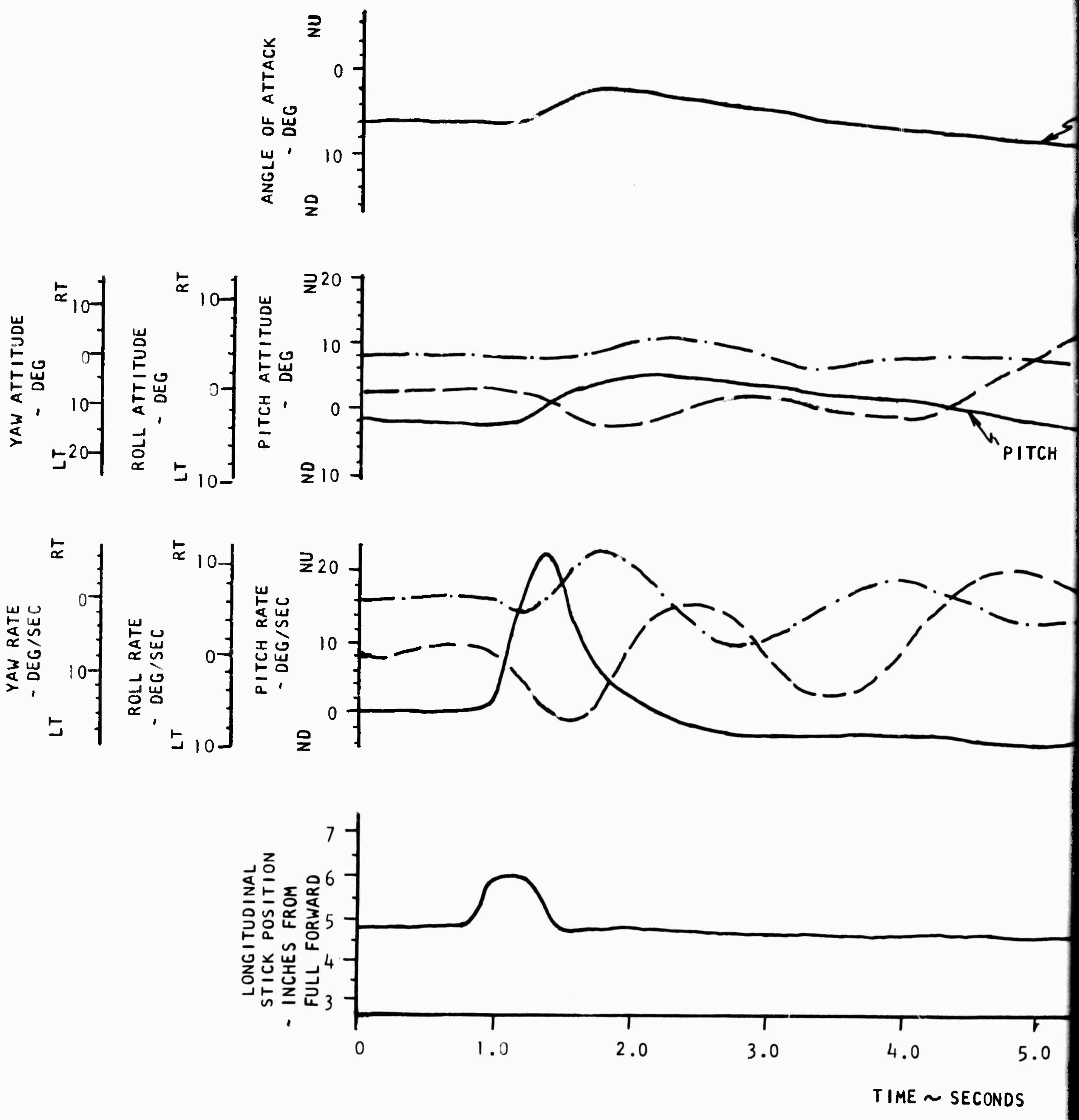


FIGURE NO. 17
AFT LONGITUDINAL PULSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITIO

LEVEL FLIGHT
TRIM AIRSPEED = 105.0 KNOTS
DENSITY ALTITUDE = 4920 FT

GROSS WEI
ROTOR SPE
C.G. LOCA



1

FIGURE NO. 17
AFT LONGITUDINAL PULSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

= 105.0 KNOTS
DE = 4920 FT

GROSS WEIGHT = 2380 LB
ROTOR SPEED = 483 RPM
C.G. LOCATION, LONG. = 97.1 (FWD)
LAT. = 1.4 (LT)

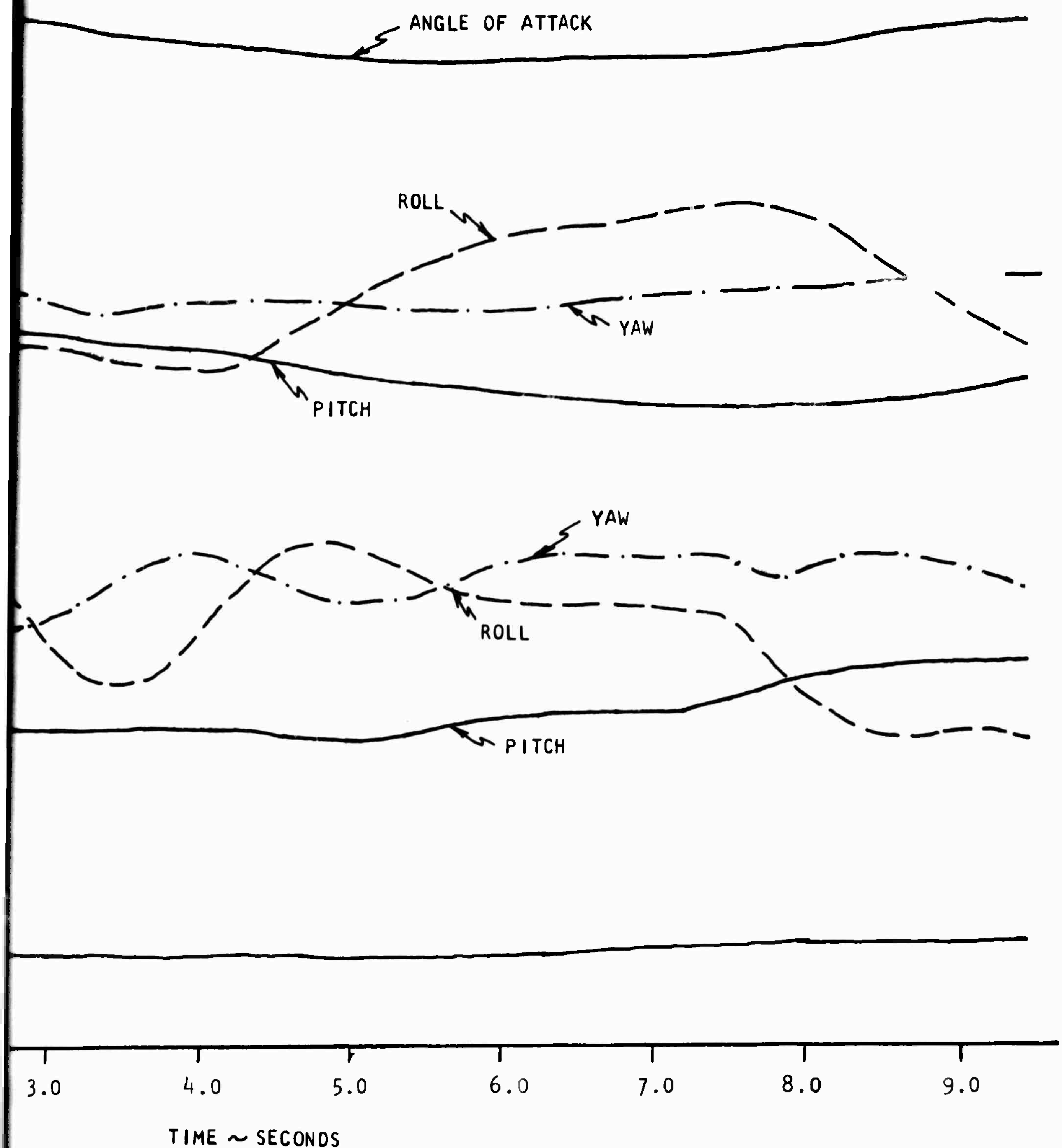
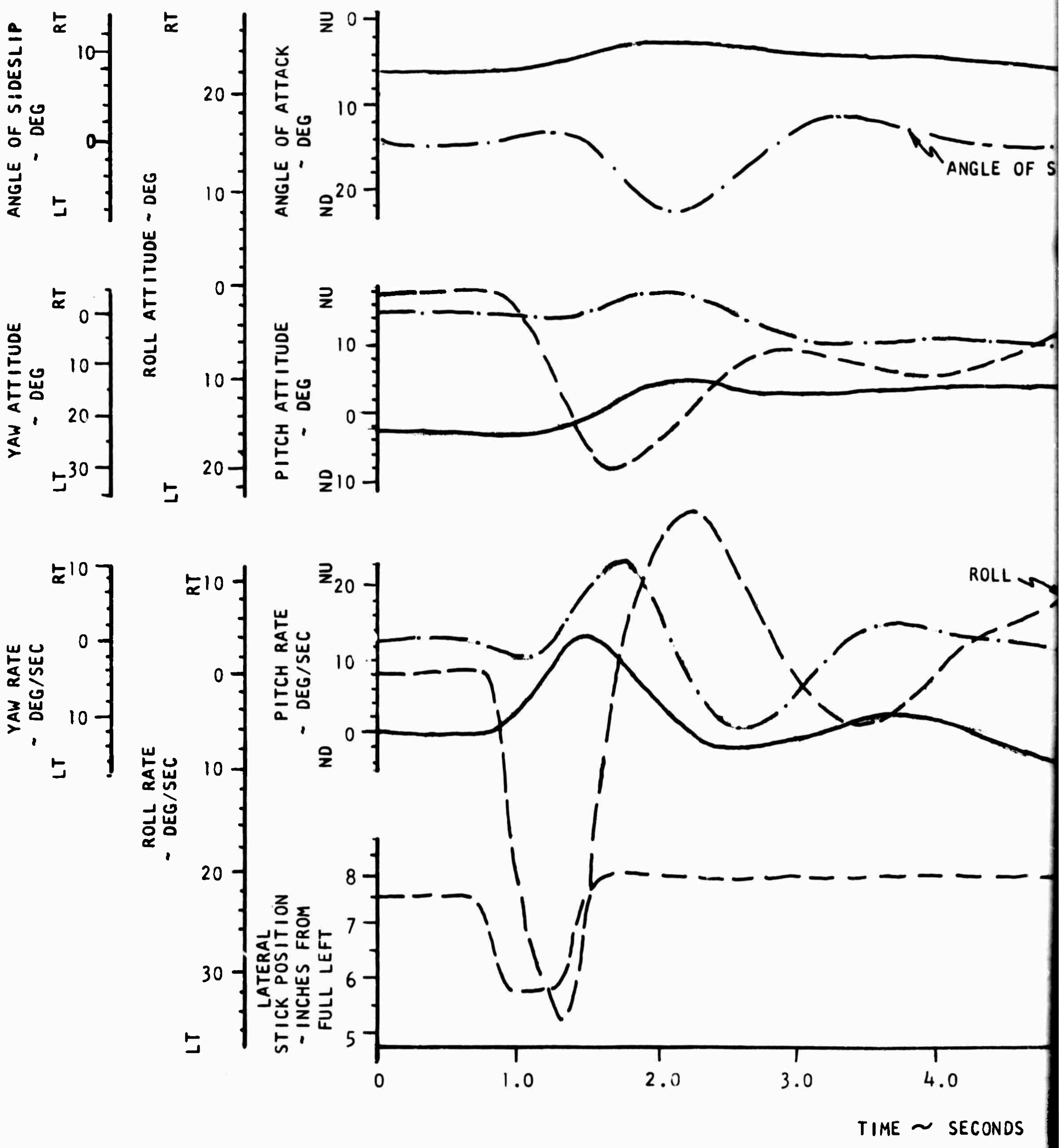


FIGURE NO. 18
LEFT LATERAL PULS
OH-6A S/N 65-129
XM-27-E1 IN STOWED POS

LEVEL FLIGHT
TRIM AIRSPEED = 105.0 KNOTS
DENSITY ALTITUDE = 4560 FT

GROSS
ROTOR
C.G.

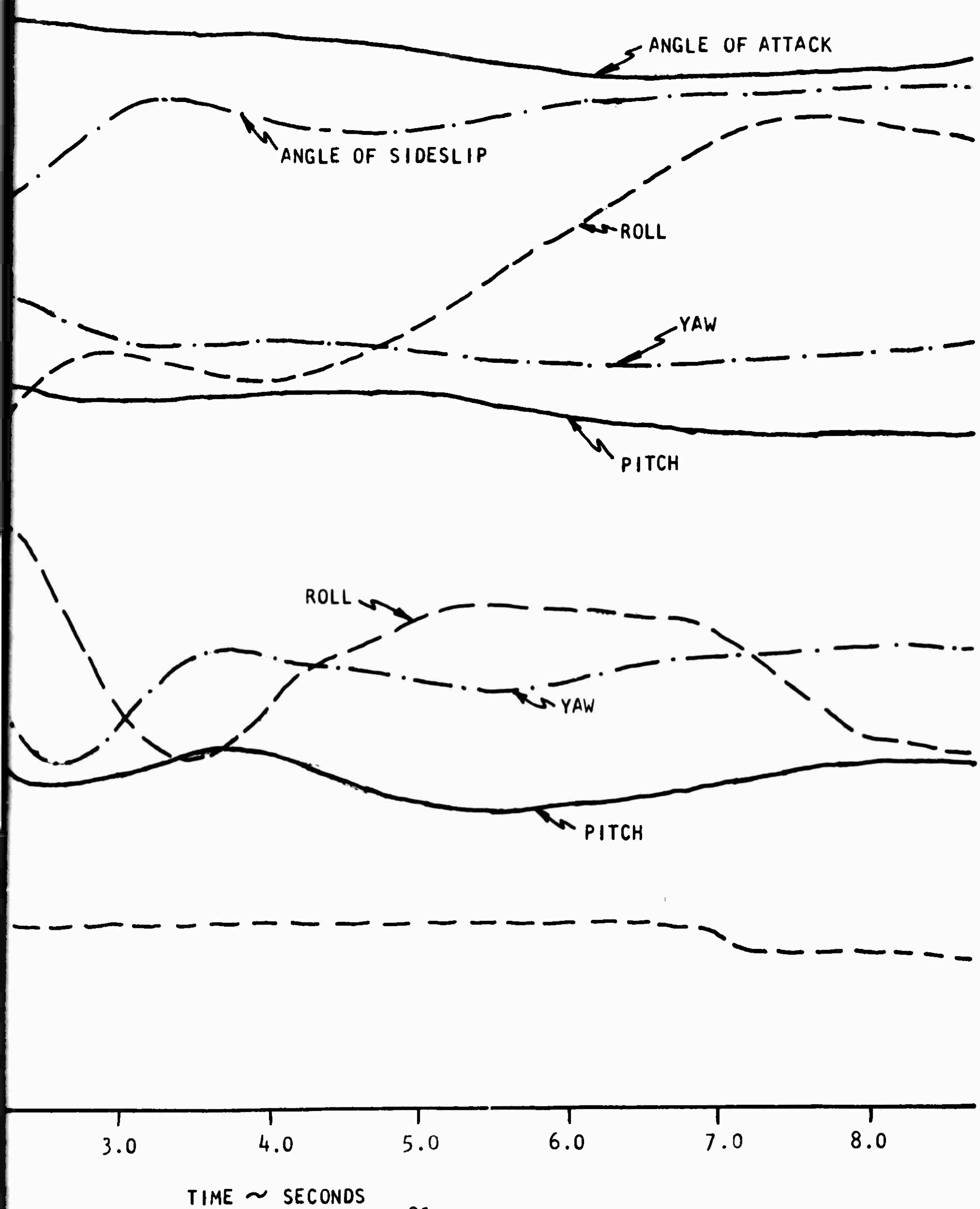


1

FIGURE NO. 18
LEFT LATERAL PULSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

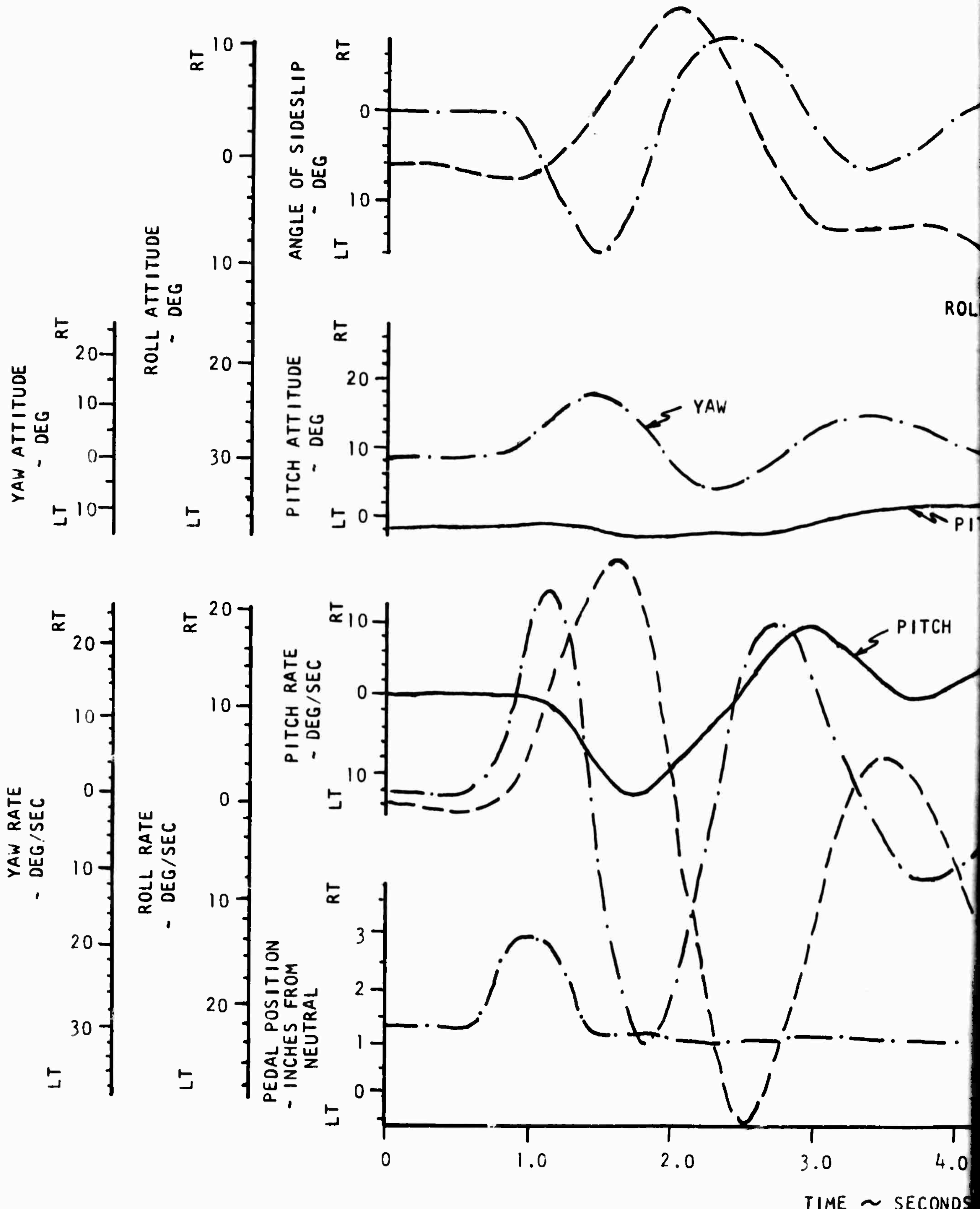
FLIGHT
IRSPEED = 105.0 KNOTS
Y ALTITUDE = 4560 FT

GROSS WEIGHT = 2350 LB
ROTOR SPEED = 483 RPM
C.G. LOCATION, LONG. = 97.1 (FWD)
LAT. = 1.4 (LT)



FIGU
RIGHT DIREC
OH-6A S
XM-27-E1 IN S

LEVEL FLIGHT
TRIM AIRSPEED = 105.0 KNOTS
DENSITY ALTITUDE = 4700 FT

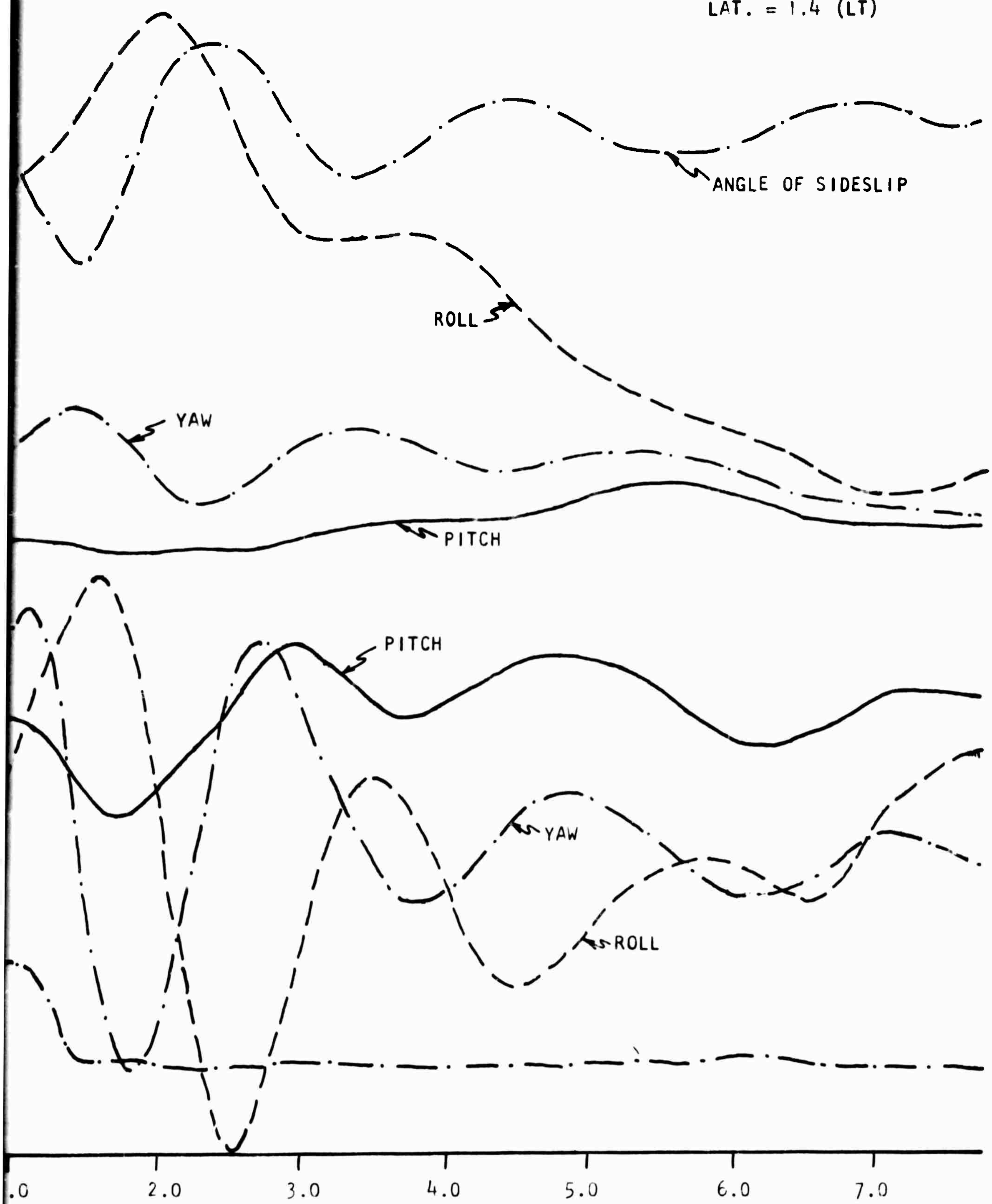


1

FIGURE NO. 19
RIGHT DIRECTIONAL PULSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION

LEVEL FLIGHT
TRIM AIRSPEED = 105.0 KNOTS
DENSITY ALTITUDE = 4700 FT

GROSS WEIGHT = 2350 LB
ROTOR SPEED = 483 RPM
C.G. LOCATION, LONG. = 97.1 (FWD)
LAT. = 1.4 (LT)



2

FIGURE NO. 20
SUMMARY OF CONTROL RESPONSE
OH-6A S/N 65-12919

DENSITY ALTITUDE = 5000 FT.
GROSS WEIGHT = 2400 LB.

C.G. LOCATION, LONG. = 97.0 (FWD)
ROTOR SPEED = 483 RPM

SYM	C.G. LOCATION, LAT.	CONFIGURATION
□	0 (MID)	CLEAN
○	1.6 (LT)	XM-27-E1 IN STOWED POSITION

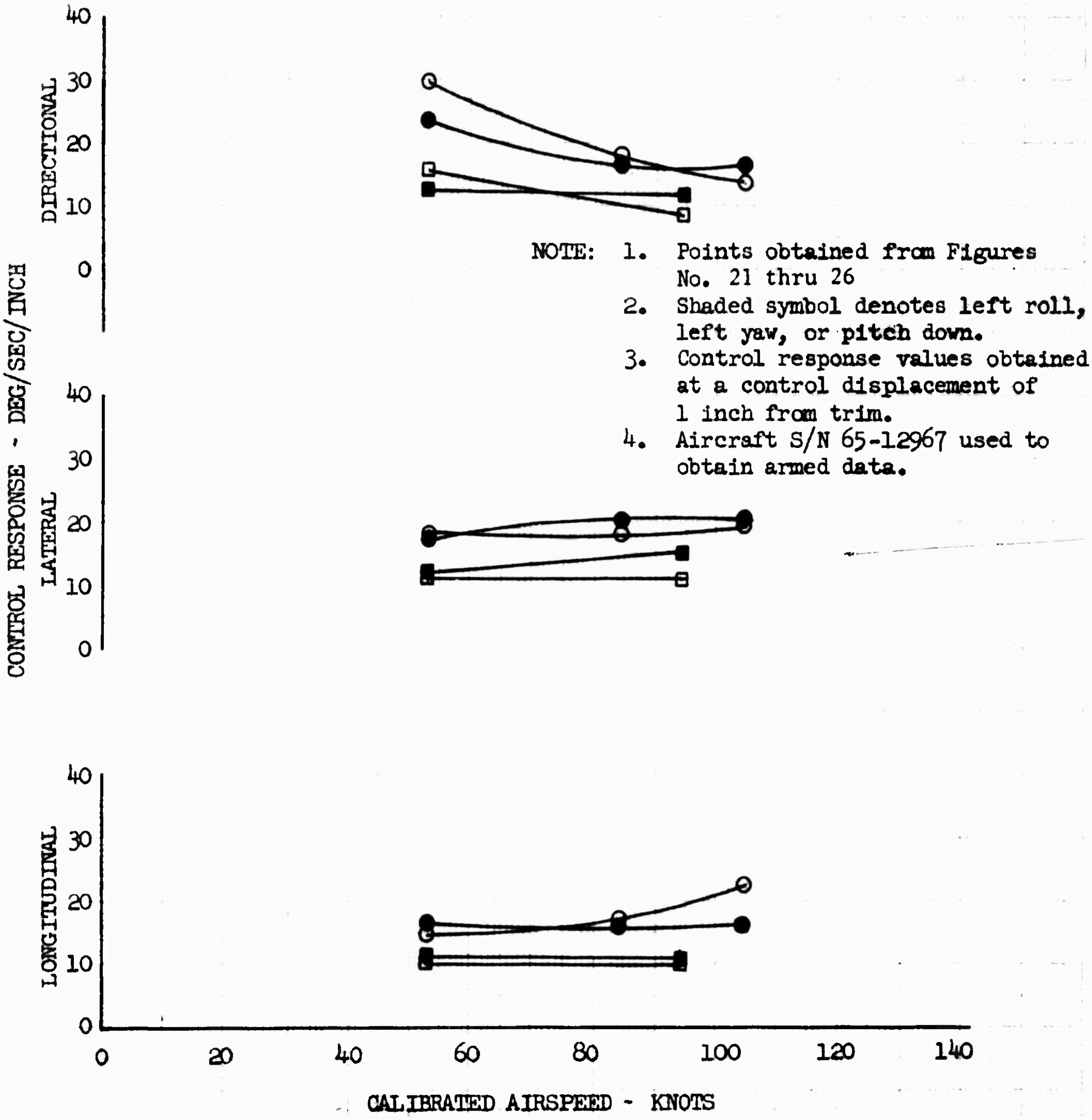


FIGURE NO. 21
LONGITUDINAL CONTROL RESPONSE
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	6380	2430	483	97.0 (fwd)	Level Flight
□	94.5	6700	2340	483	97.0 (fwd)	Level Flight

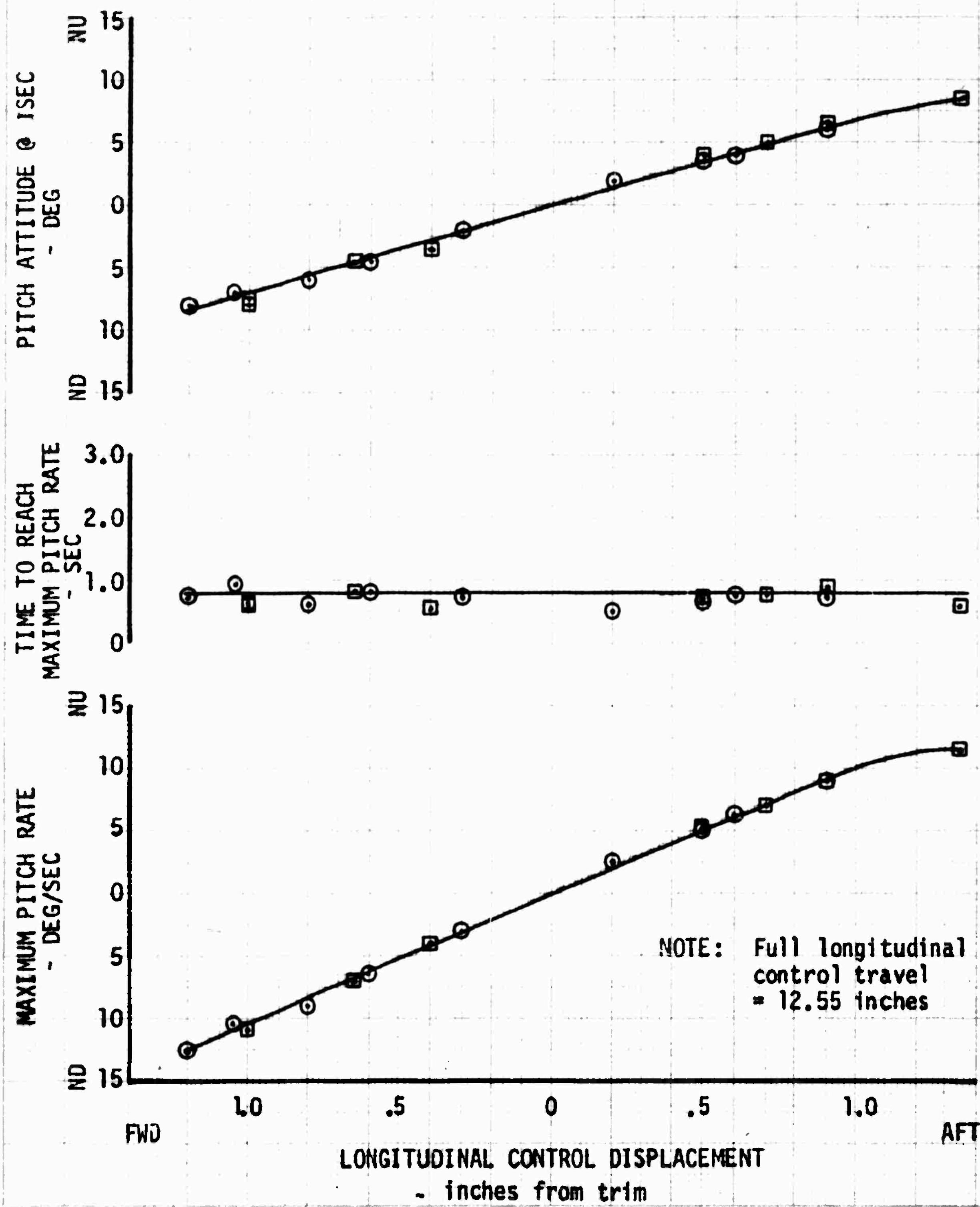


FIGURE NO. 22
LATERAL CONTROL RESPONSE
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	6210	2410	483	97.0 (fwd)	Level Flight
□	94.5	6560	2320	483	97.0 (fwd)	Level Flight

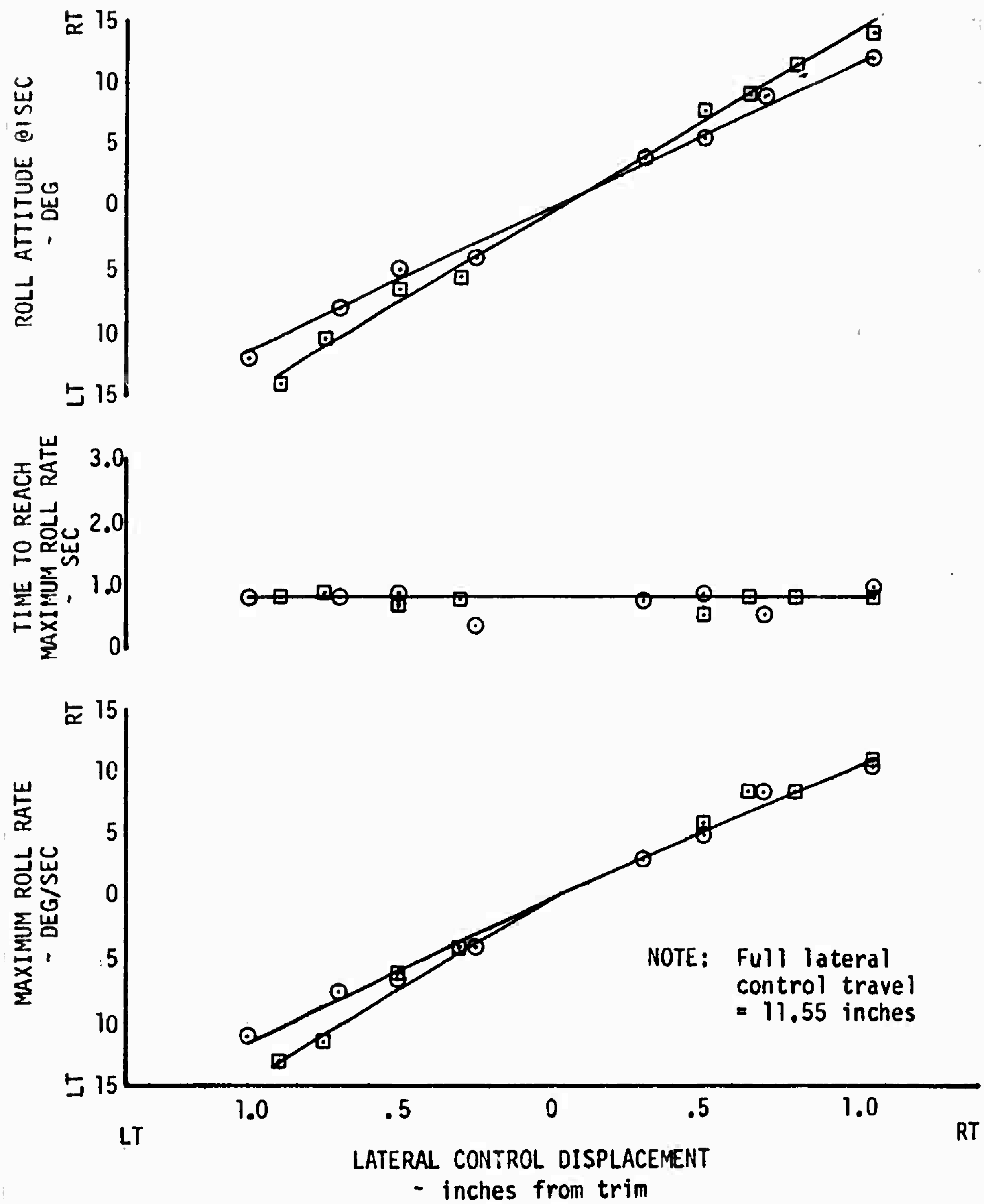


FIGURE NO. 23
DIRECTIONAL CONTROL RESPONSE
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	6180	2390	483	97.1 (fwd)	Level Flight
□	94.5	6490	2300	483	97.2 (fwd)	Level Flight

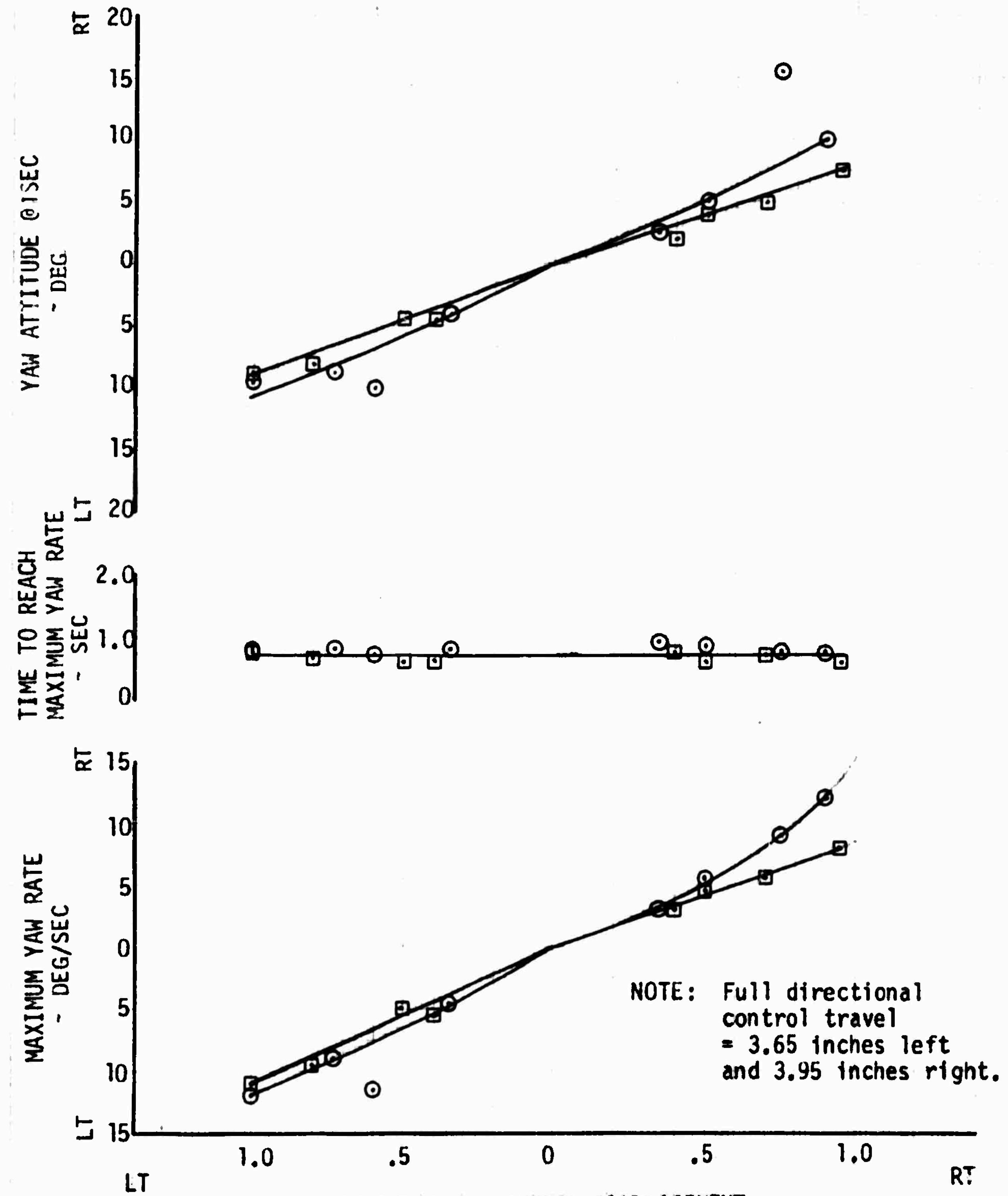


FIGURE NO. 24
LONGITUDINAL CONTROL RESPONSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION LEVEL FLIGHT

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG.	C.G. LOCATION IN LAT.
○	53.0	4500	2400	483	97.0 (fwd)	1.6 (Lt)
□	84.5	5070	2420	483	97.0 (fwd)	1.6 (Lt)
△	104.5	4880	2380	483	97.0 (fwd)	1.6 (Lt)

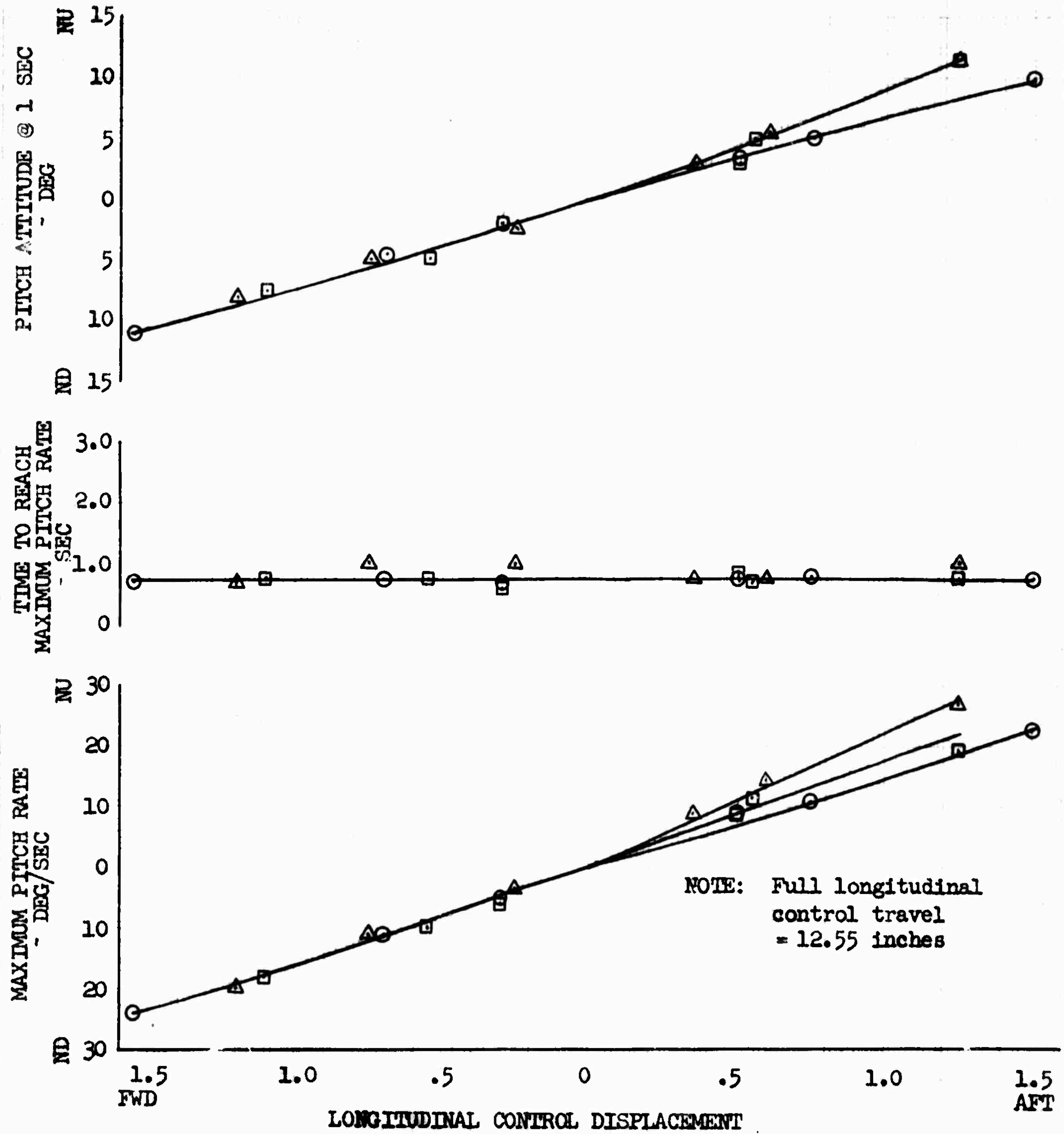
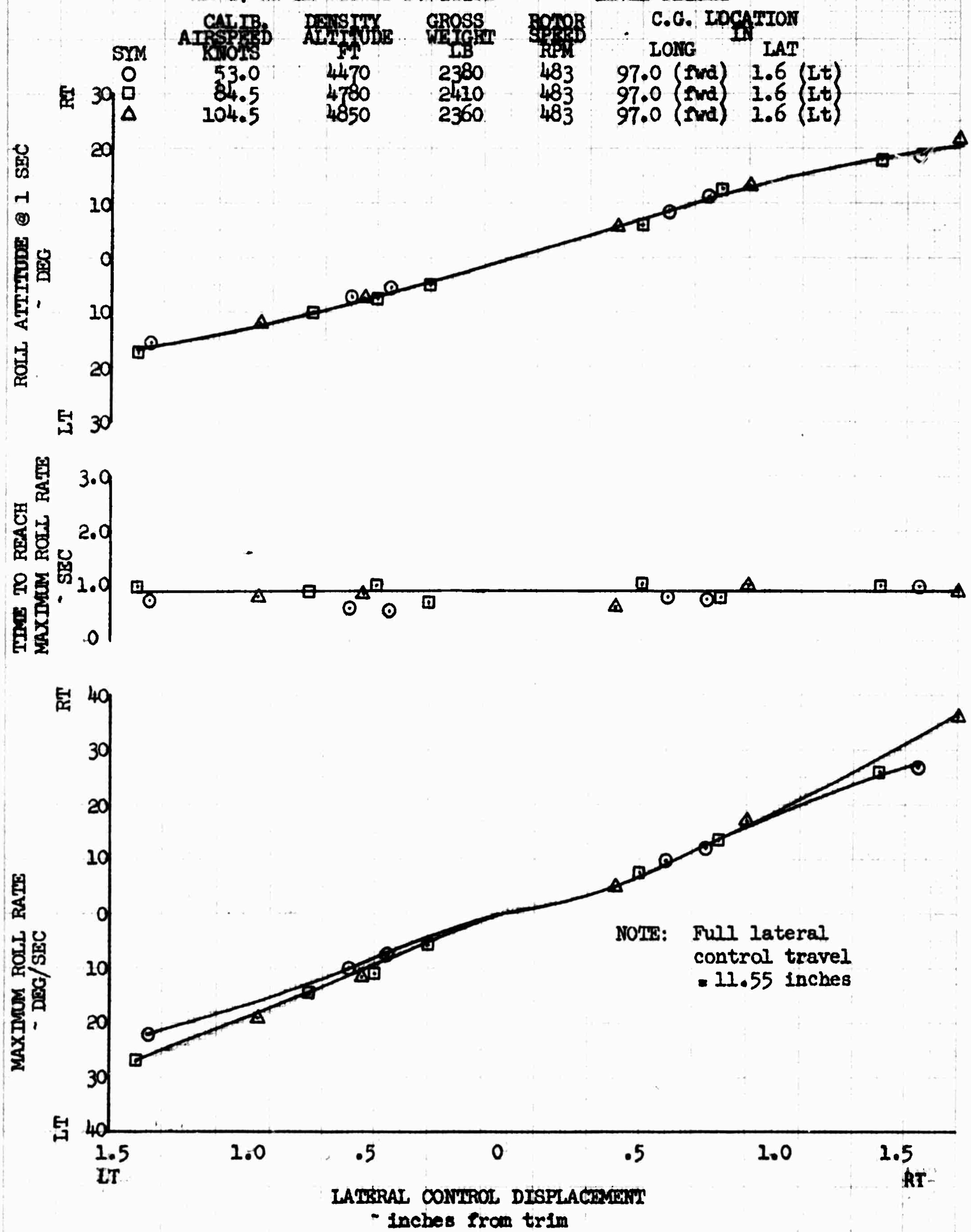


FIGURE NO. 25
LATERAL CONTROL RESPONSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION LEVEL FLIGHT



FLIGHT NO. 26
DIRECTIONAL CONTROL RESPONSE
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION LEVEL FLIGHT

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG	C.G. LOCATION IN LAT
○	53.0	4300	2370	483	97.0 (fwd)	1.6 (Lt)
□	84.5	4800	2400	483	97.0 (fwd)	1.6 (Lt)
△	104.5	4720	2340	483	97.0 (fwd)	1.6 (Lt)

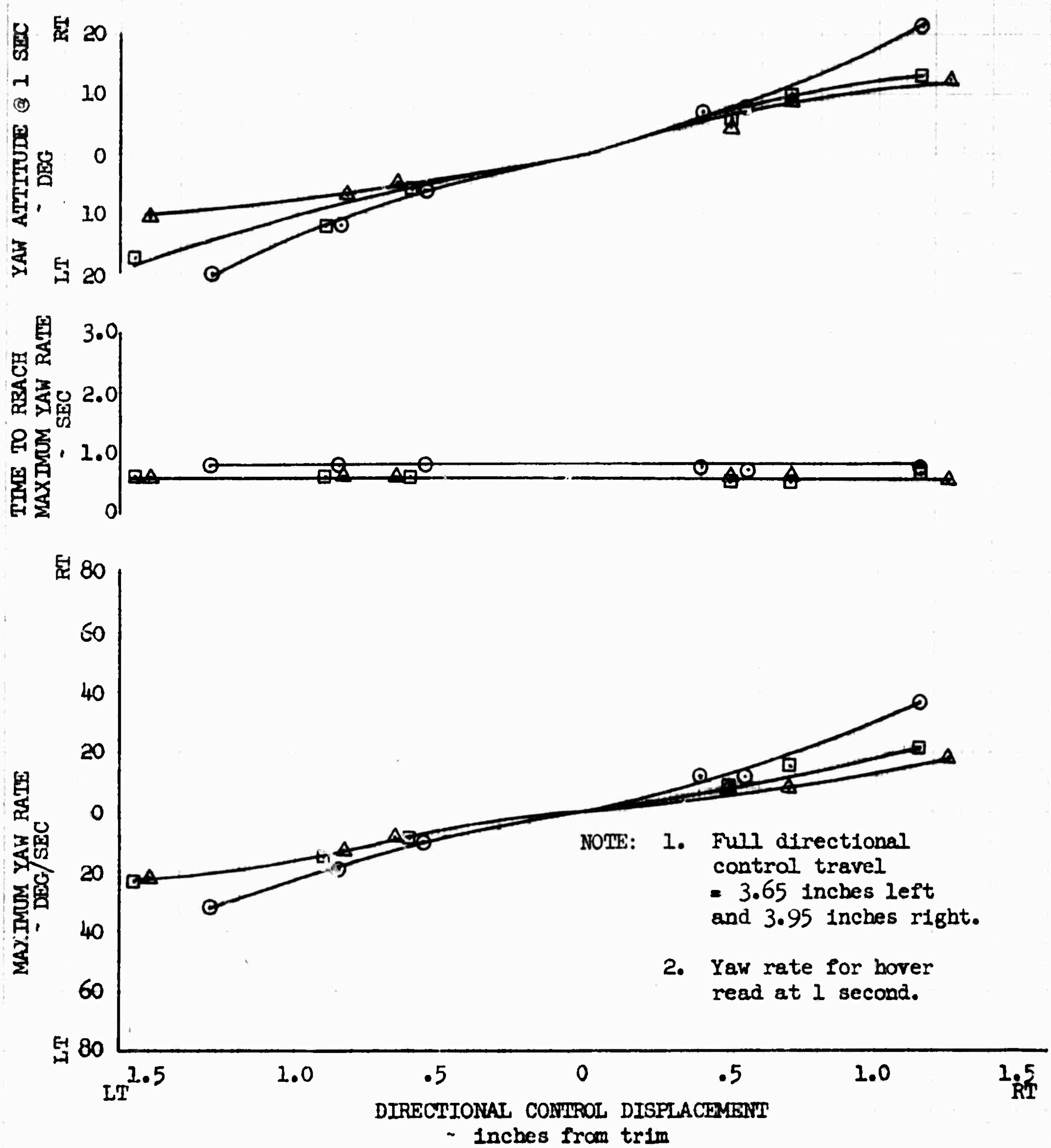
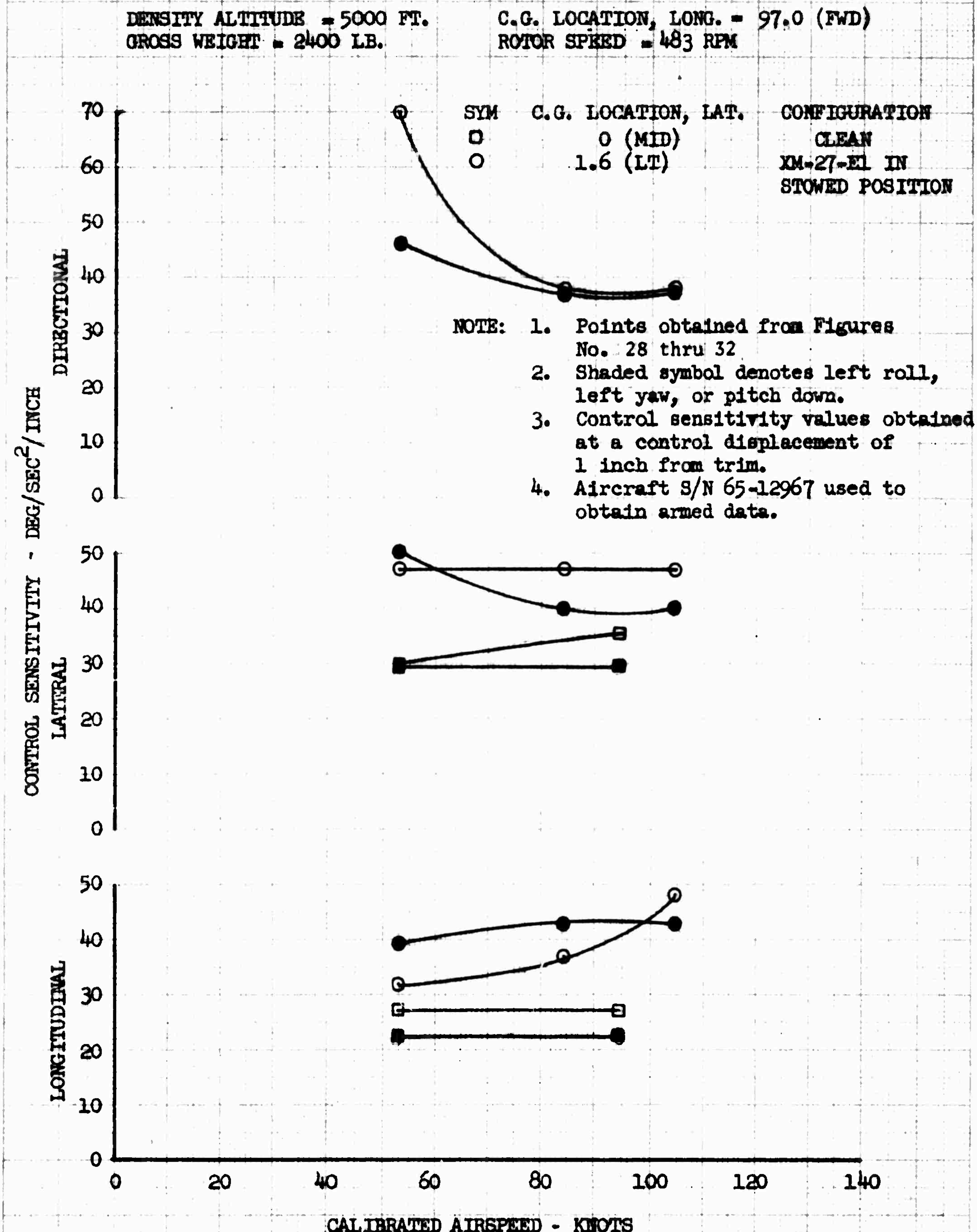
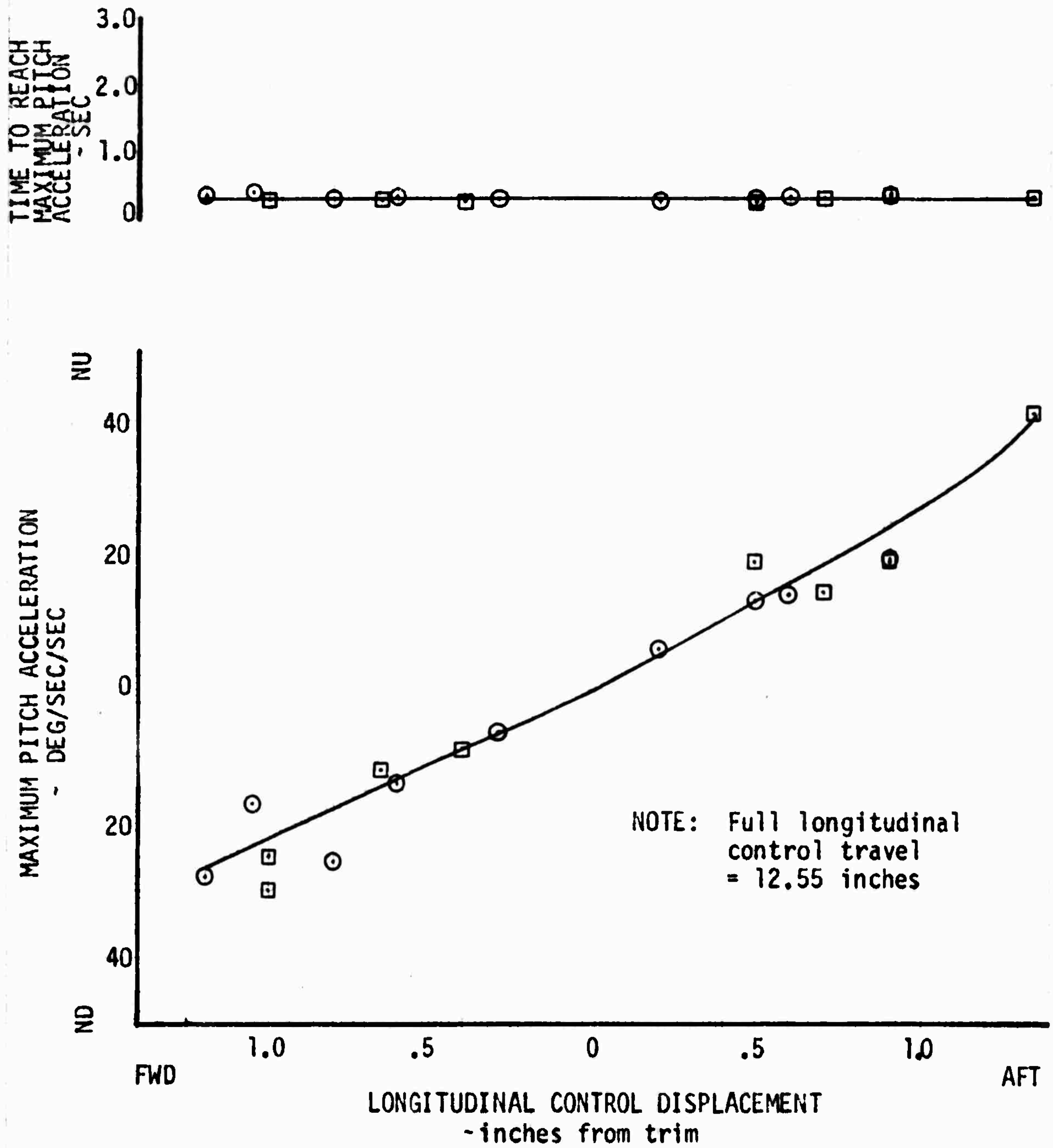


FIGURE NO. 27
SUMMARY OF CONTROL SENSITIVITY
OH-6A S/N 65-12919



LONGITUDINAL CONTROL SENSITIVITY
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	6370	2430	483	97.0 (fwd)	Level Flight
⊡	94.5	6700	2340	483	97.0 (fwd)	Level Flight



LATERAL CONTROL SENSITIVITY
OH-6A S/N 65-12919
CLEAN CONFIGURATION

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
○	53.0	6210	2410	483	97.0 (fwd)	Level Flight
□	94.5	6560	2320	483	97.0 (fwd)	Level Flight

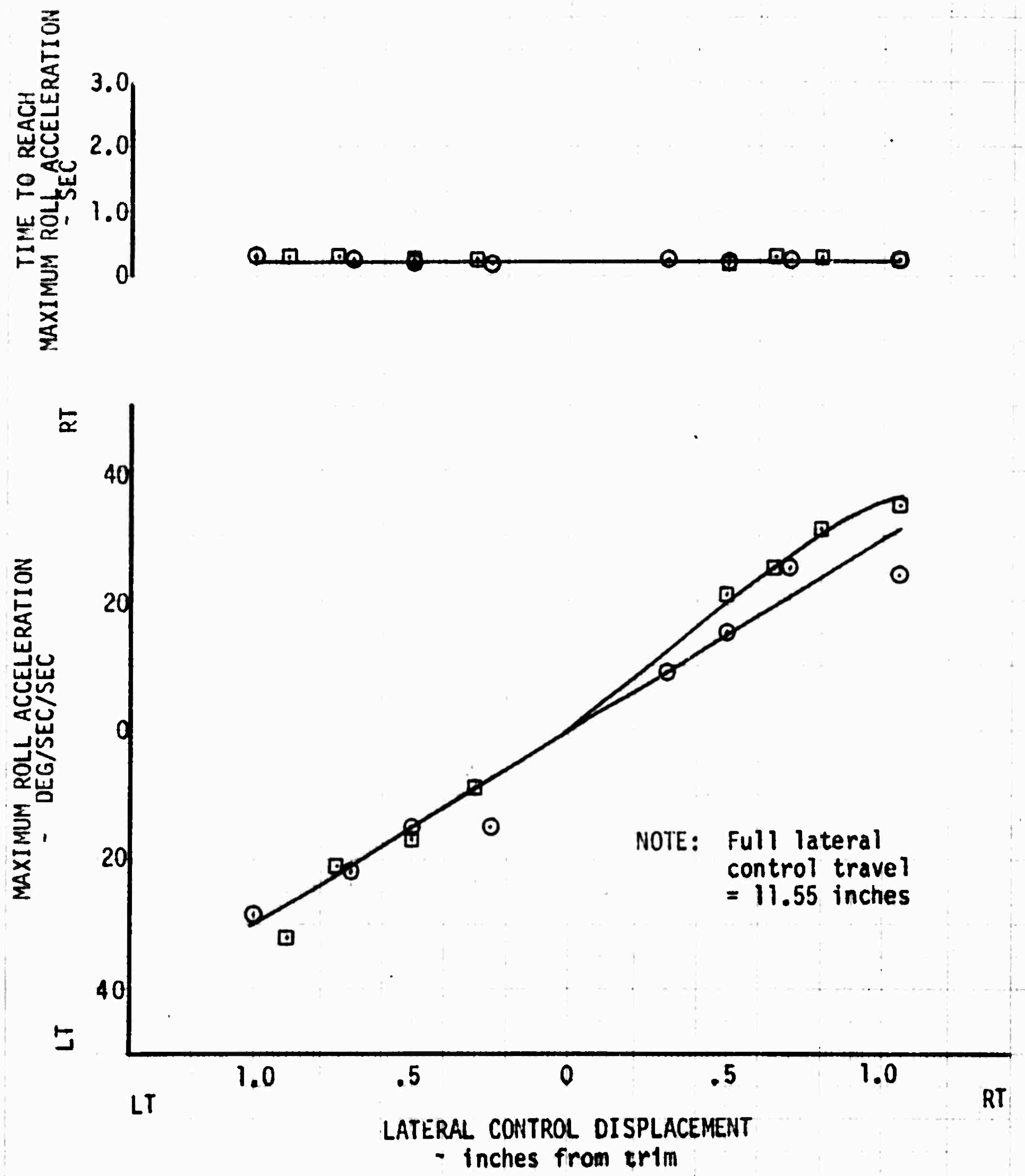


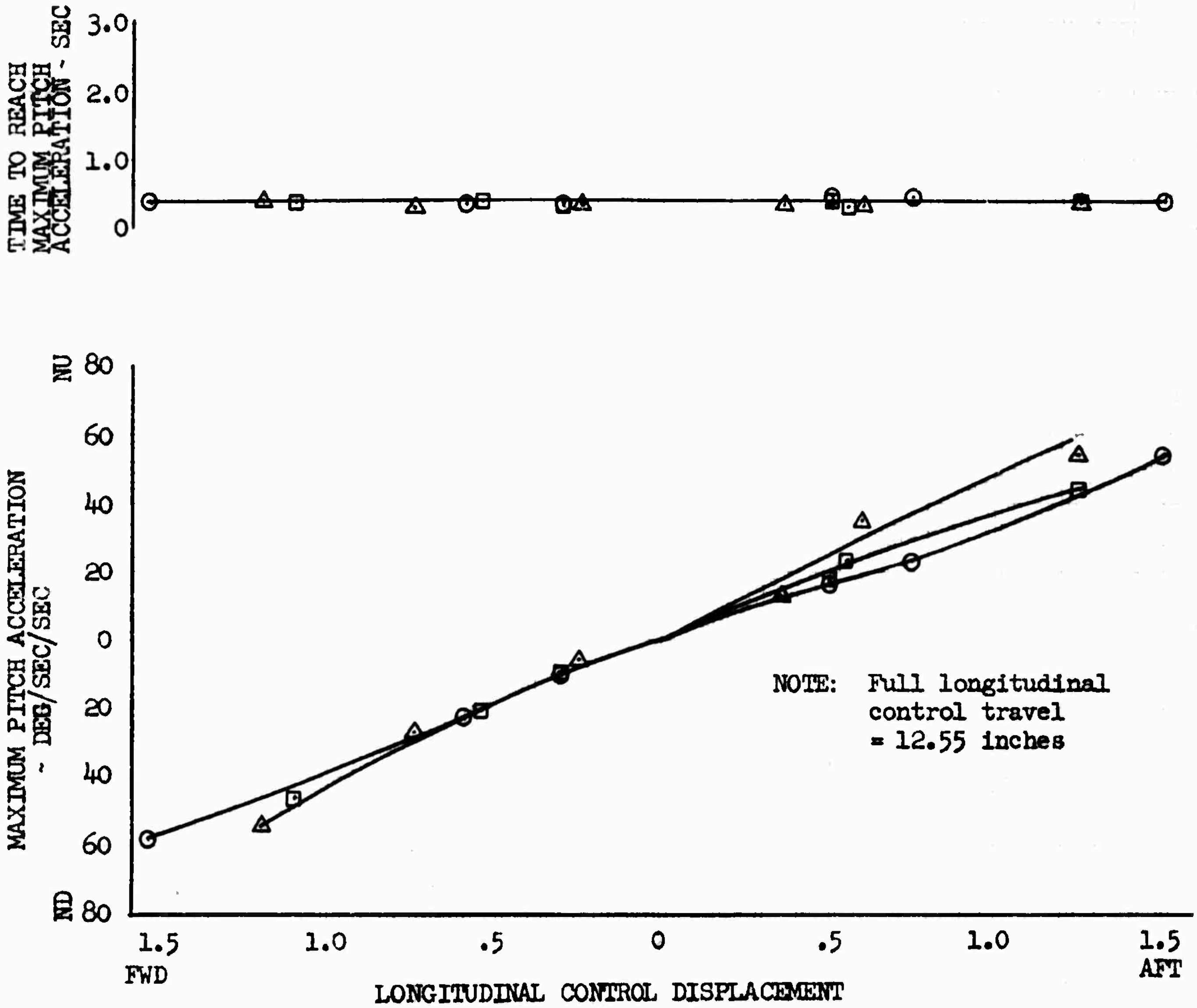
FIGURE NO. 30

LONGITUDINAL CONTROL SENSITIVITY

OH-6A S/N 65-12967

XM-27-E1 IN STOWED POSITION LEVEL FLIGHT

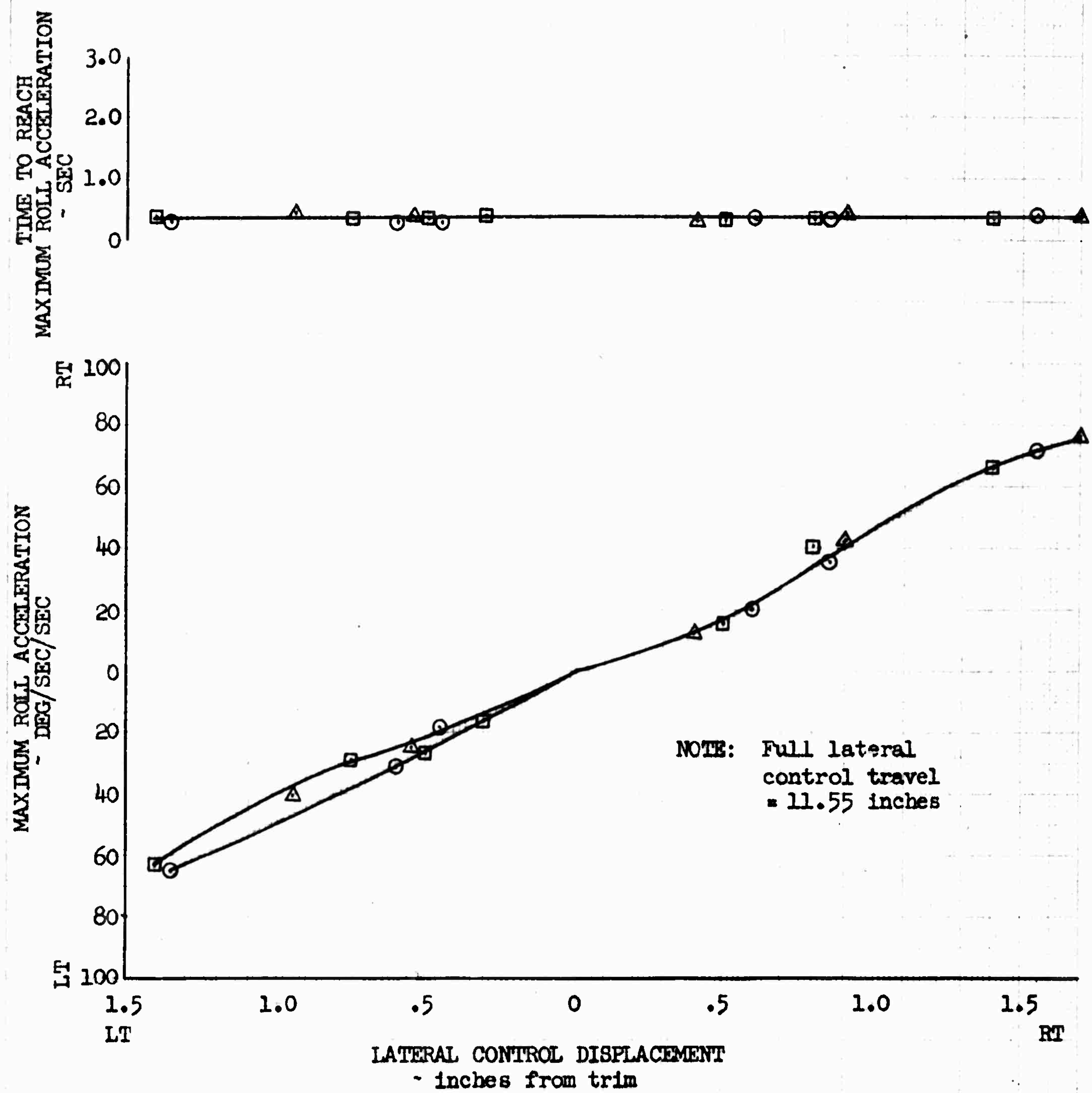
SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG	C.G. LOCATION IN LAT
○	53.0	4500	2400	483	97.0 (fwd)	1.6 (Lt)
□	84.5	5070	2420	483	97.0 (fwd)	1.6 (Lt)
△	104.5	4880	2380	483	97.0 (fwd)	1.6 (Lt)



OH-6A S/N 65-12967

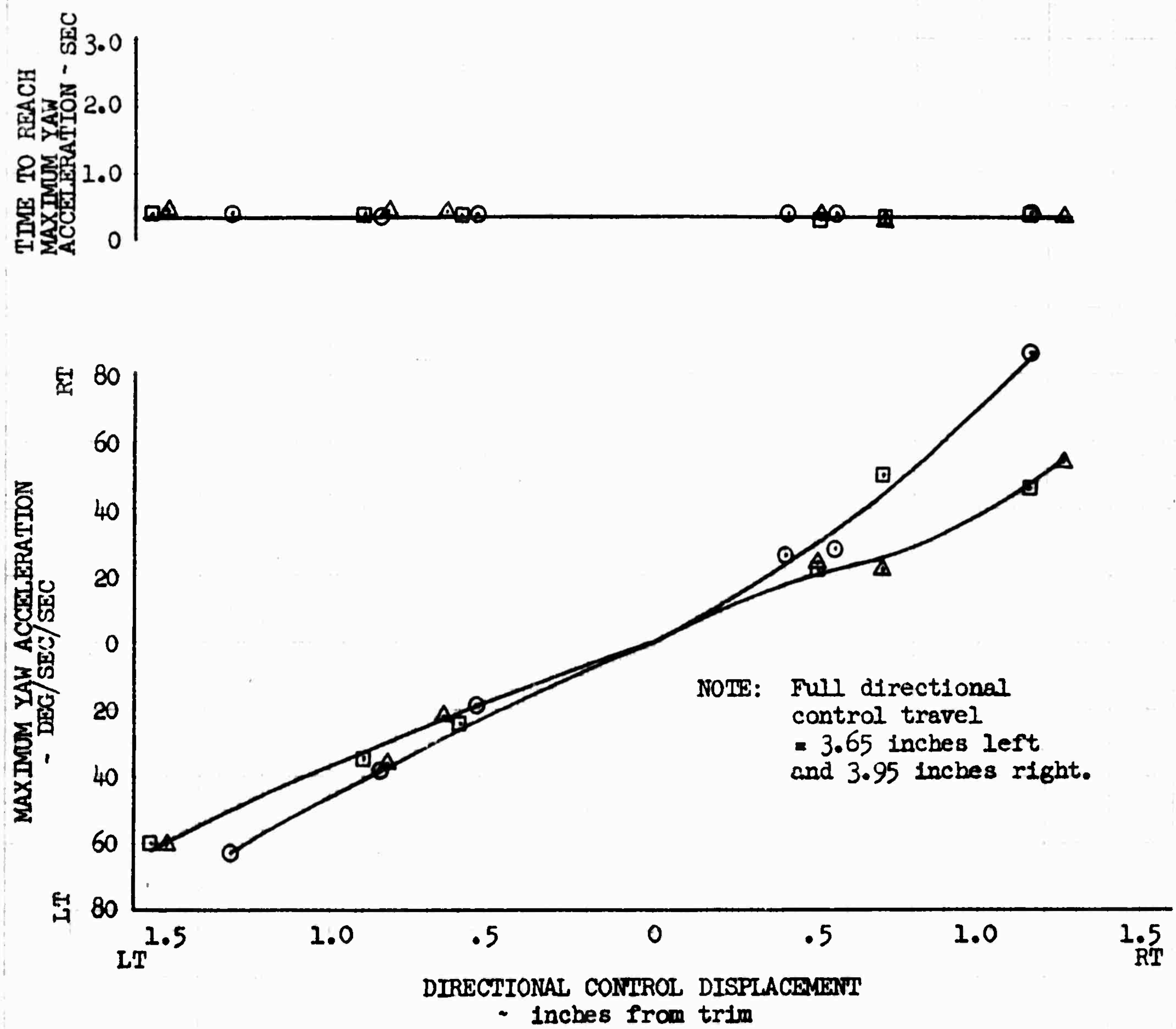
XM-27-E1 IN STOWED POSITION LEVEL FLIGHT

SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG	C.G. LOCATION IN LAT
○	53.0	4470	2380	483	97.0 (fwd)	1.6 (Lt)
□	84.5	4780	2410	483	97.0 (fwd)	1.6 (Lt)
△	104.5	4850	2360	483	97.0 (fwd)	1.6 (Lt)



DIRECTIONAL CONTROL SENSITIVITY
OH-6A S/N 65-12967
XM-27-E1 IN STOWED POSITION LEVEL FLIGHT

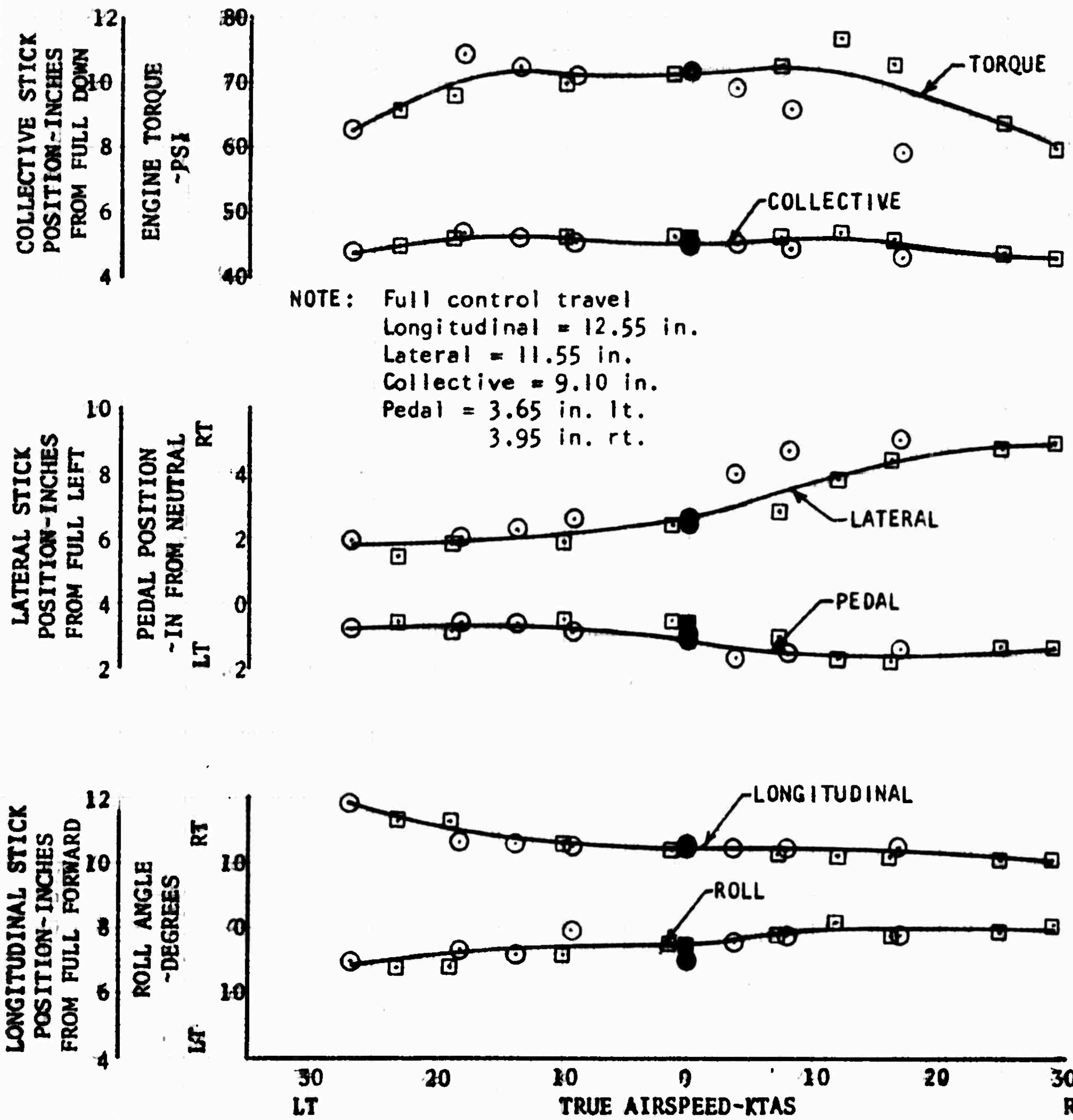
SYM	CALIB. AIRSPEED KNOTS	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG	C.G. LOCATION IN LAT
○	53.0	4300	2370	483	97.0 (fwd)	1.6 (Lt)
□	84.5	4800	2400	483	97.0 (fwd)	1.6 (Lt)
△	104.5	4720	2340	483	97.0 (fwd)	1.6 (Lt)



OH-6A S/N 65-12919

CLEAN CONFIGURATION IGE (10 FEET)

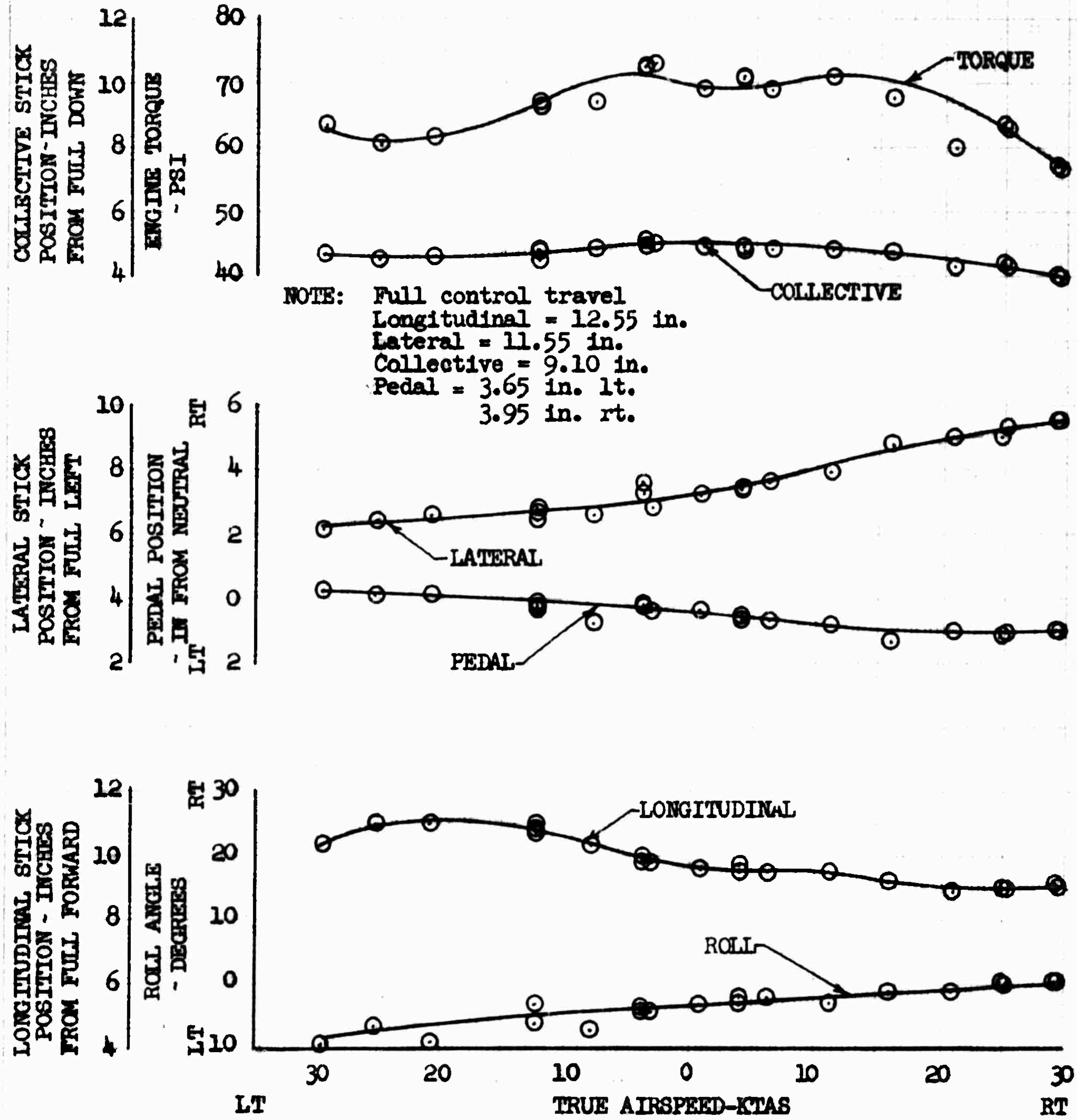
SYM	CONTROL RIGGING	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG.	C.G. LOCATION IN LAT.
○	OLD	-100	2470	483	97.0(FWD)	2.3(LT)
□	NEW	-400	2470	483	97.0(FWD)	2.3(LT)



CONTROL POSITIONS DURING SIDEWARD FLIGHT
OH-6A S/N 65-12967

XM-27-E1 IN STOWED POSITION IGE (10 FEET)

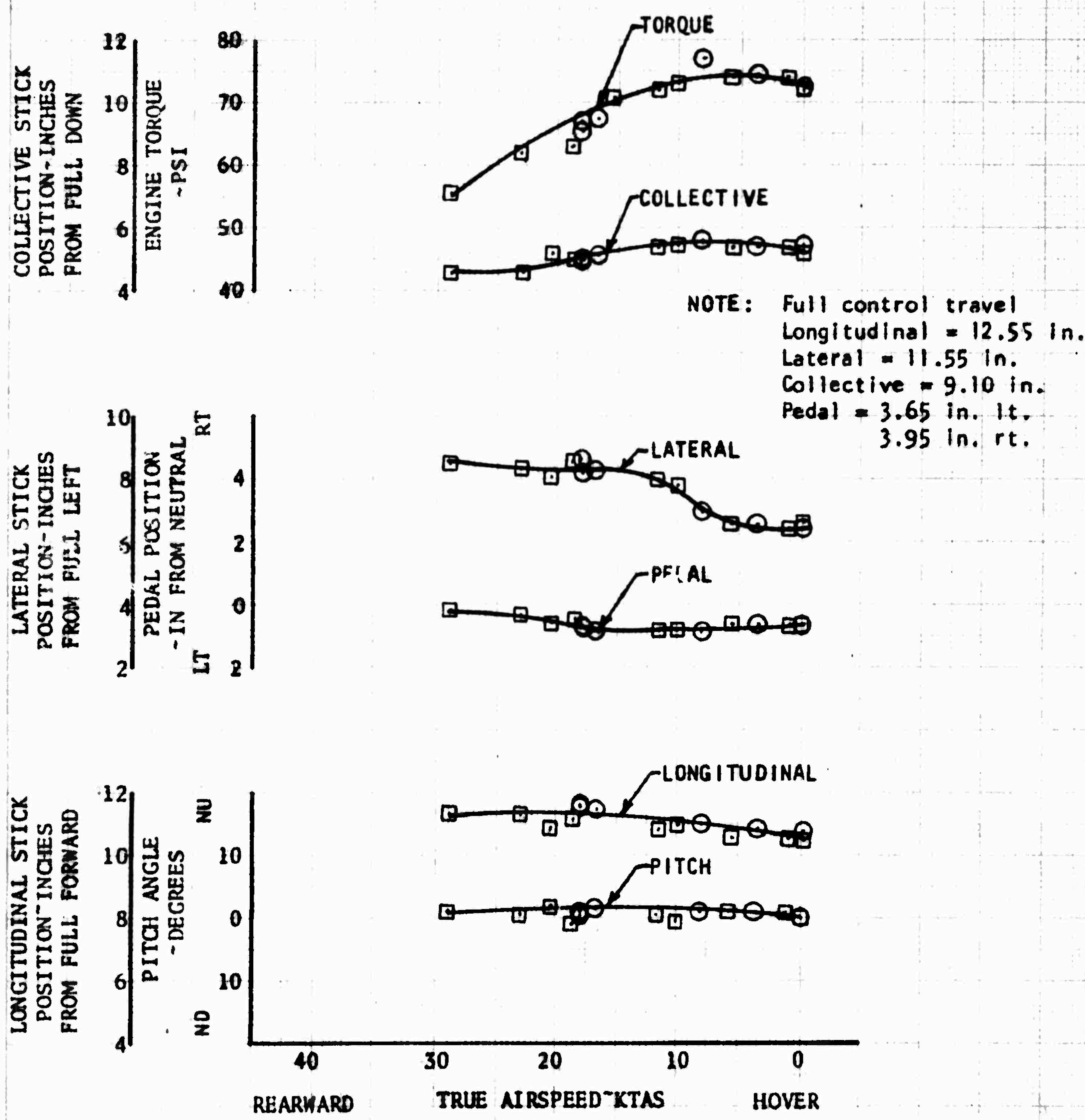
SYM	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG.	C.G. LOCATION IN LAT.
O	1070	2430	483	97.1 (FWD)	2.0 (LT)



OH-6A S/N 65-12919

CLEAN CONFIGURATION IGE (10 FEET)

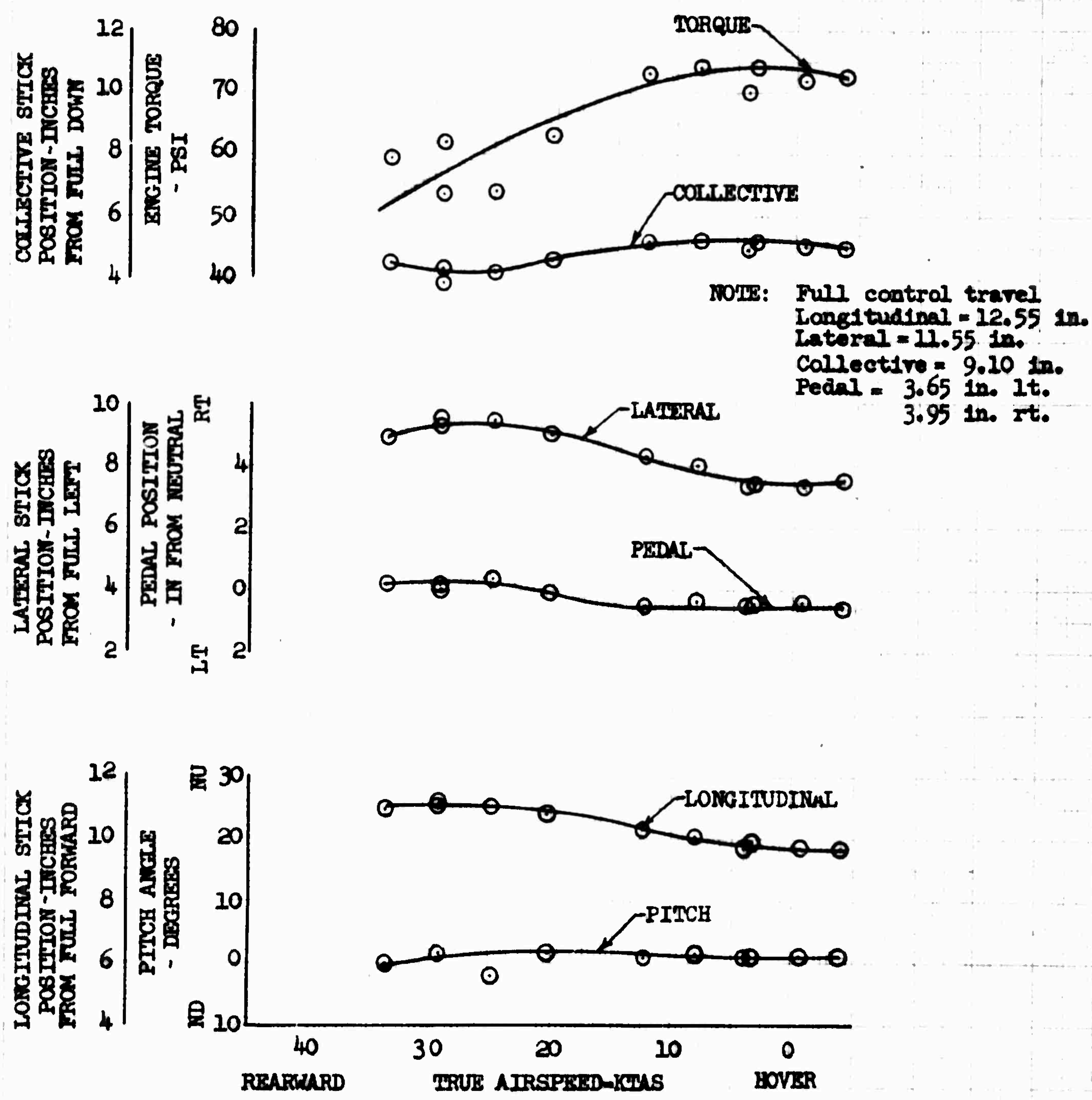
SYM	CONTROL RIGGING	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG.	C.G. LOCATION IN LAT.
○	OLD	-100	2470	483	97.0 (fwd)	2.3 (LT)
□	NEW	-400	2470	483	97.0 (fwd)	2.3 (LT)



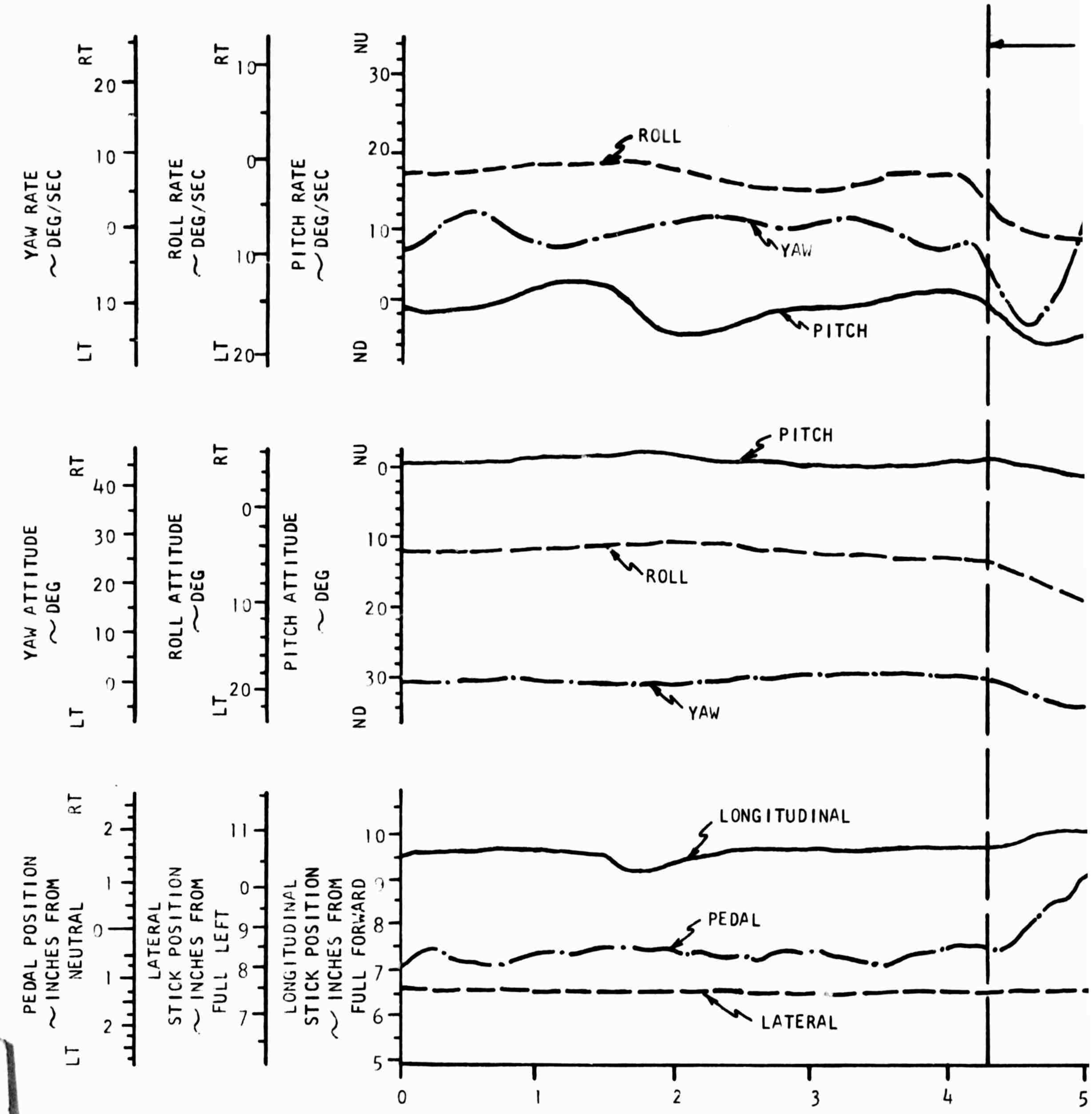
CONTROL POSITIONS DURING REARWARD FLIGHT
OH-6A S/N 65-12967

XM-27-E1 IN STOWED POSITION IGE (10 FEET)

SYM	DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN LONG.	C.G. LOCATION IN LAT.
○	1260	2400	483	97.1 (FWD)	2.0 (LT)



TRIM AIRSPEED = 0
DENSITY ALTITUDE = 3680 FT.
C.G. LOCATION = Sta. 97.1 (FWD)



RE NO. 37
EAPON FIRING
/N 65-12967
O.G.E.

GROSS WEIGHT = 2380 LB.
ROTOR SPEED = 483 RPM
FWD) GUN ELEVATED

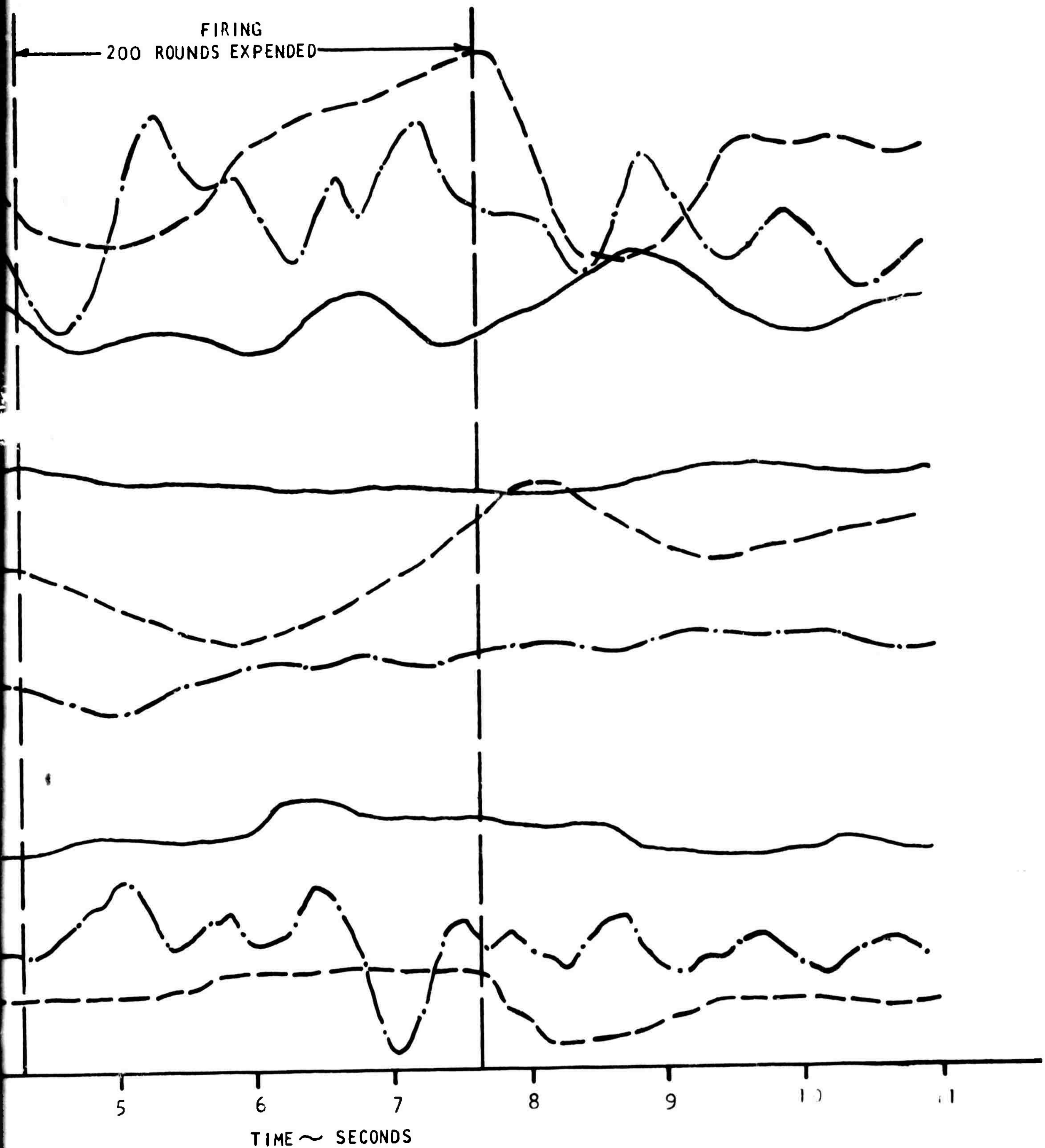
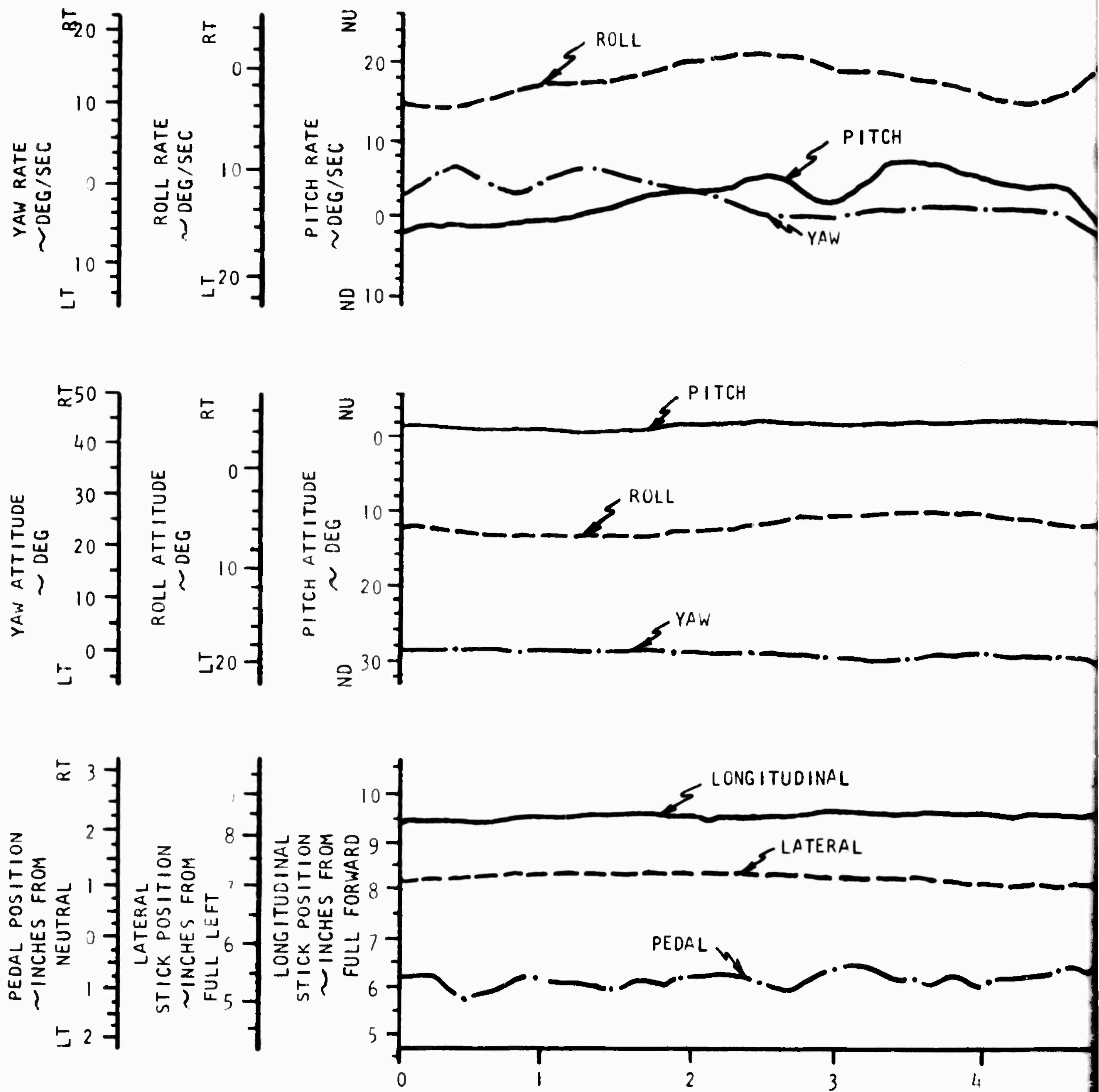


FIGURE NO.
XM-27-E1 WEAPON
OH-6A S/N 65-
HOVER O.G.E

TRIM AIRSPEED = 0
DENSITY ALTITUDE = 3680 FT.
C.G. LOCATION = Sta. 97.1 (FWD)



1

IGURE NO. 38
1 WEAPON FIRING
S/N 65-12967
VER O.G.E.

T. GROSS WEIGHT = 2380 LB.
ROTOR SPEED = 483 RPM
(FWD) GUN DEPRESSED

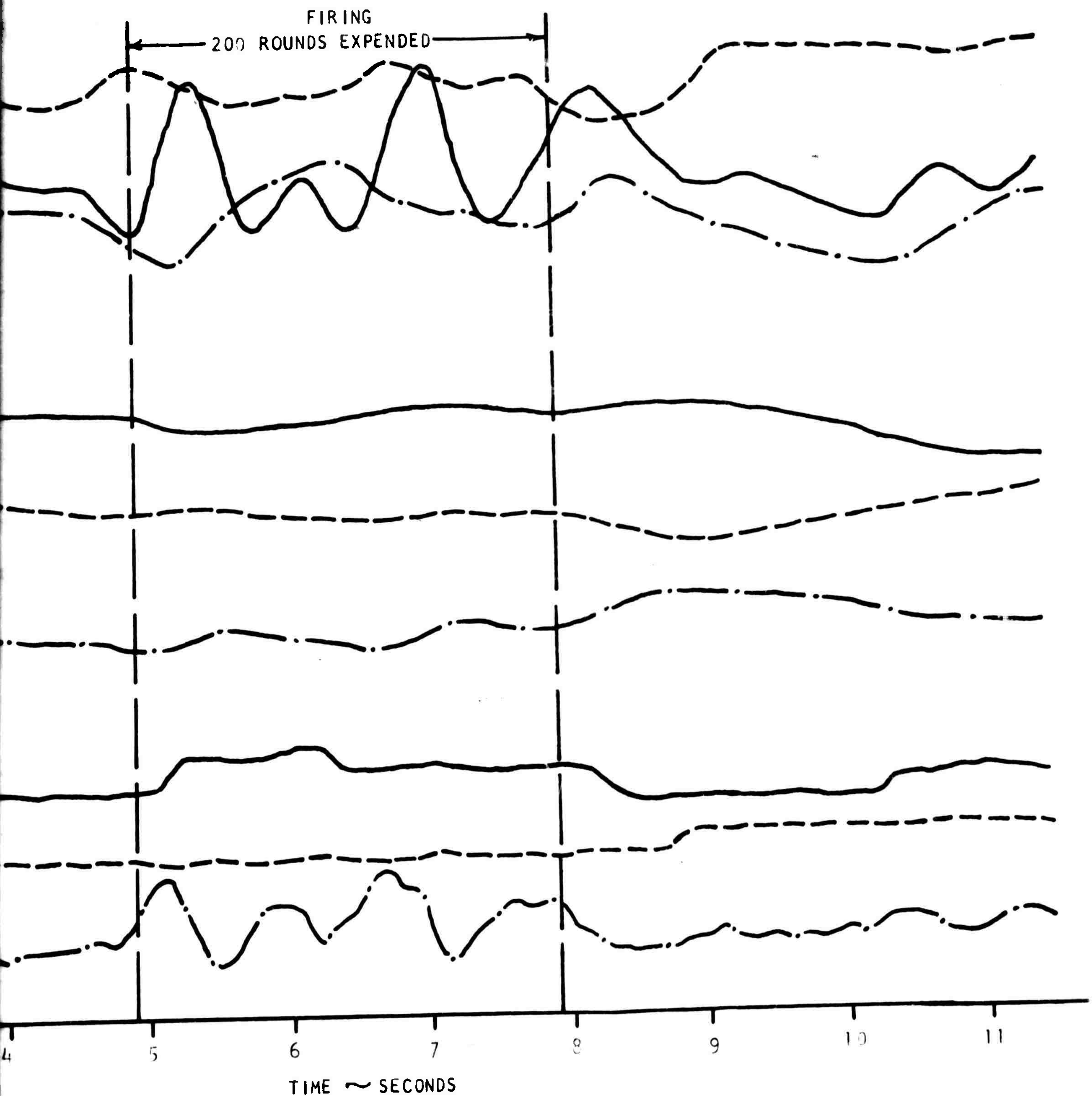
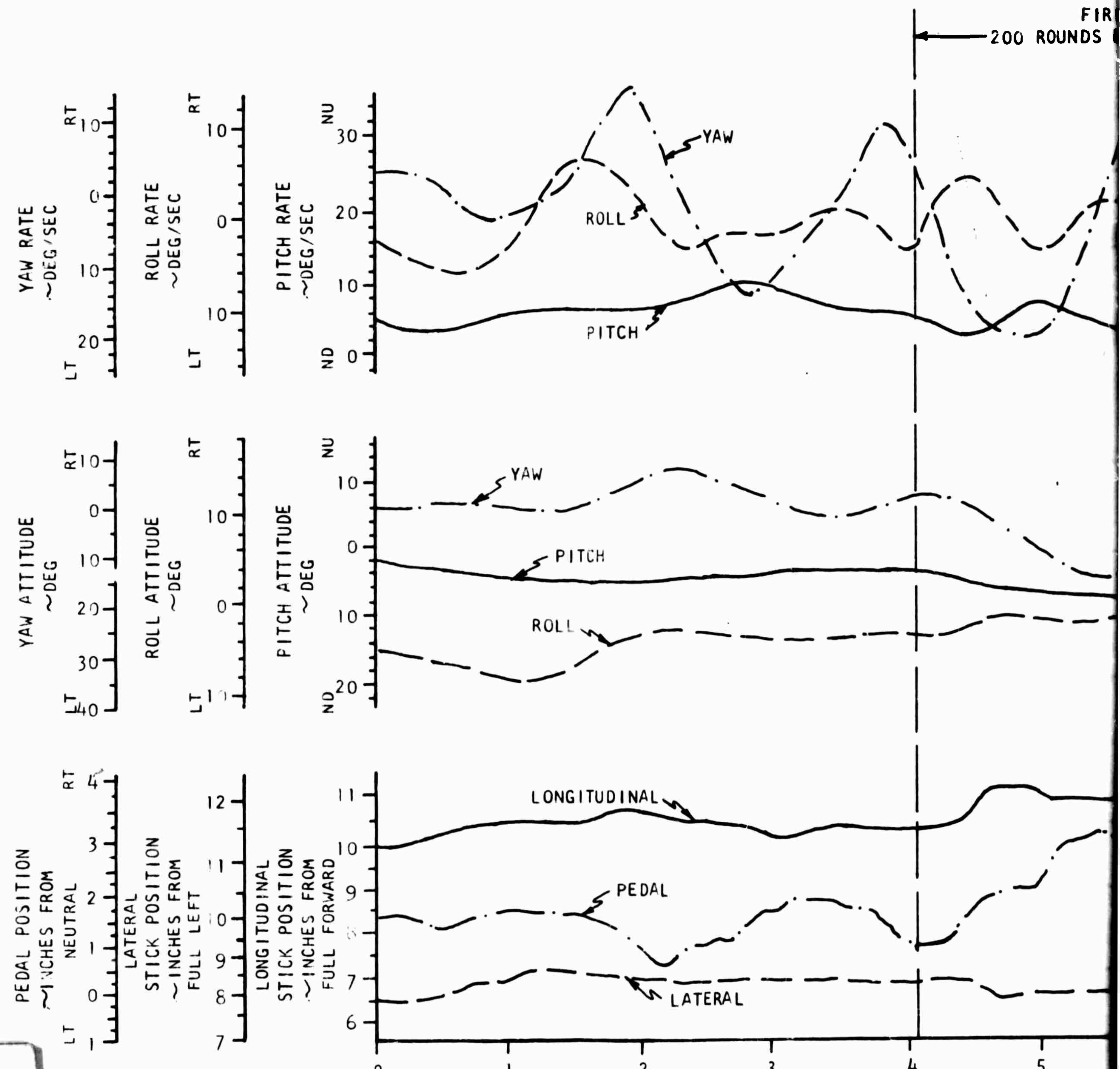


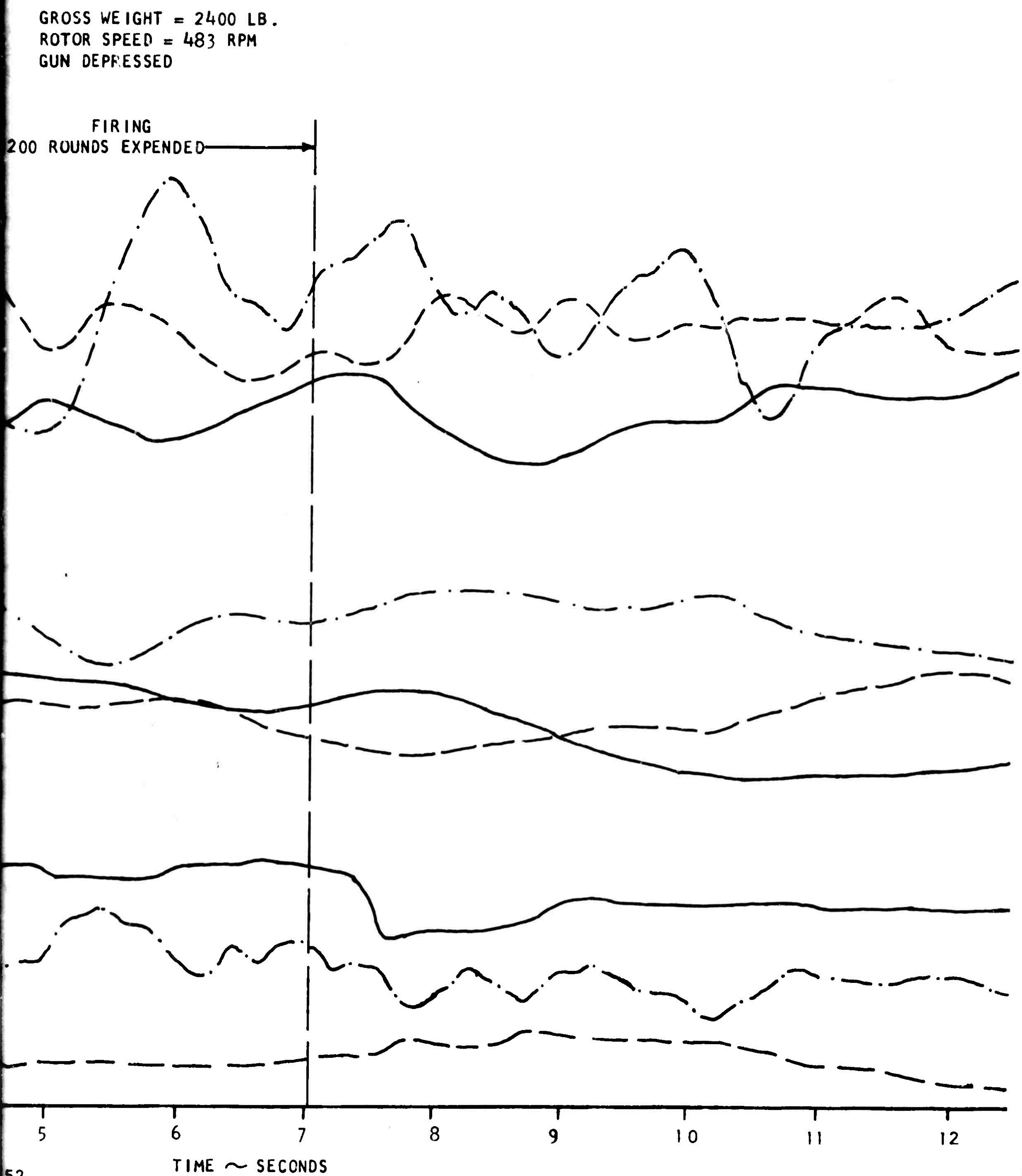
FIGURE NO. 39
XM-27-E1 WEAPON FIRING
OH-6A S/N 65-12967
REARWARD FLIGHT

TRIM AIRSPEED = 14 KCAS
DENSITY ALTITUDE = 3490 FT.
C.G. LOCATION = Sta. 97.1 (FWD)

GROSS WE
ROTOR SPE
GUN DEPRE



). 39
} FIRING
3-12967
IGHT



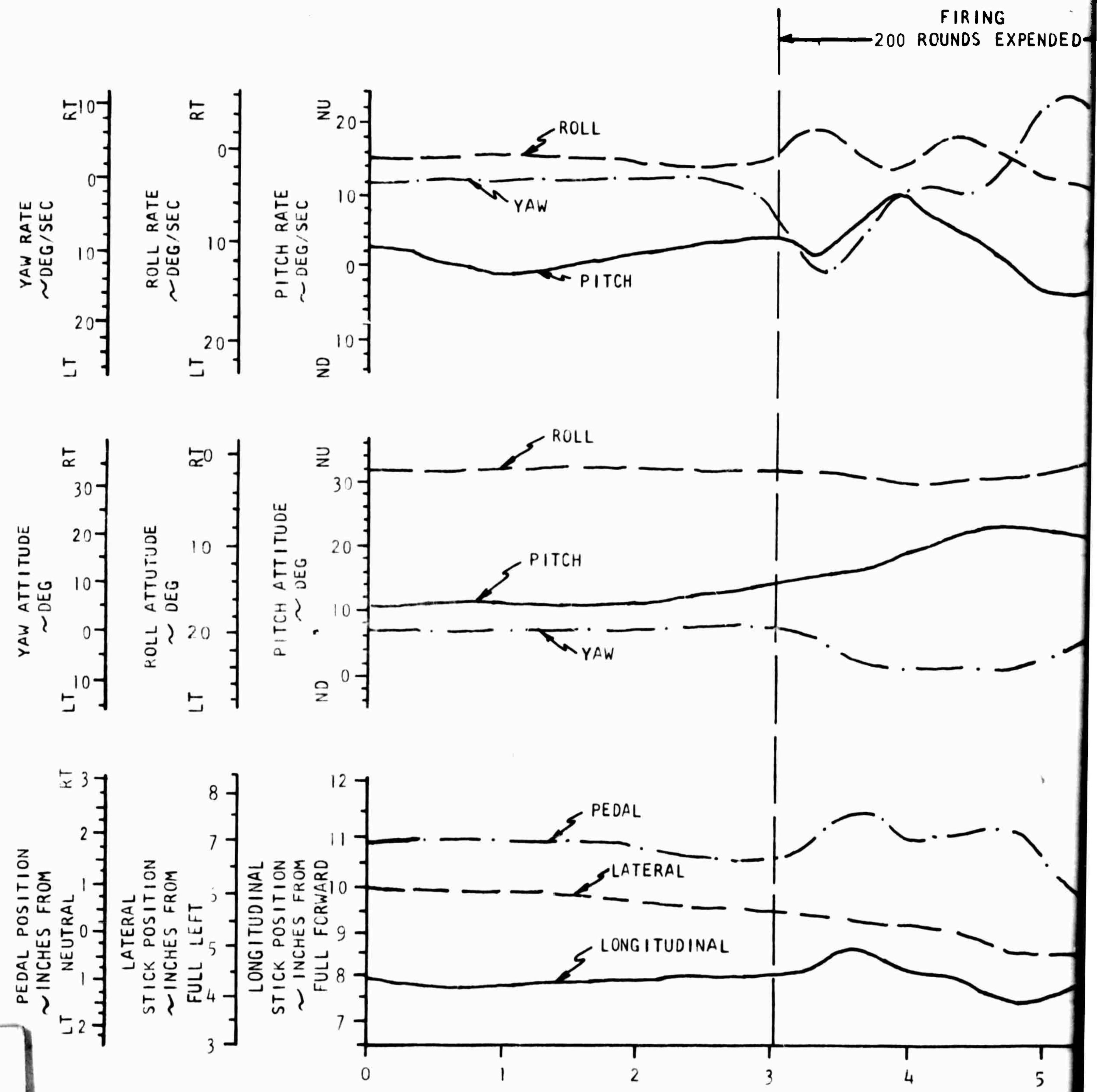
52

2

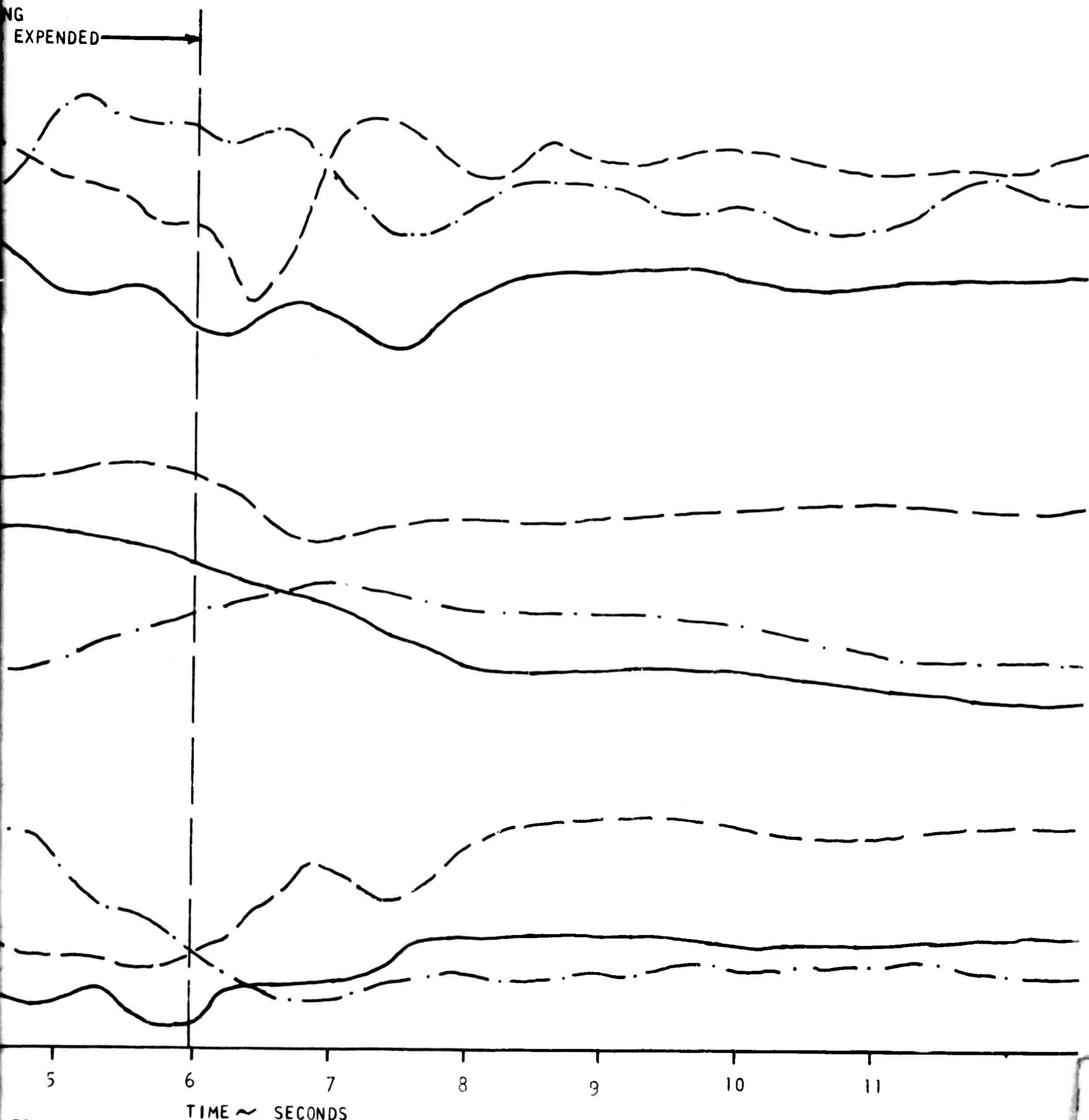
FIGURE NO.40
XM-27-E1 WEAPON FIRING
OH-6A S/N 65-12967
TRANSITION FROM FORWARD FLIGHT TO

TRIM AIRSPEED = 18 KCAS TO HOVER
DENSITY ALTITUDE = 3260 FT.
C.G. LOCATION = Sta. 97.1 (FWD)

GROS
ROTO
GUN



NO.40
ON FIRING
65-12967
FLIGHT TO A HOVER
R GROSS WEIGHT = 2400 LB.
ROTOR SPEED = 483 RPM
GUN DEPRESSED



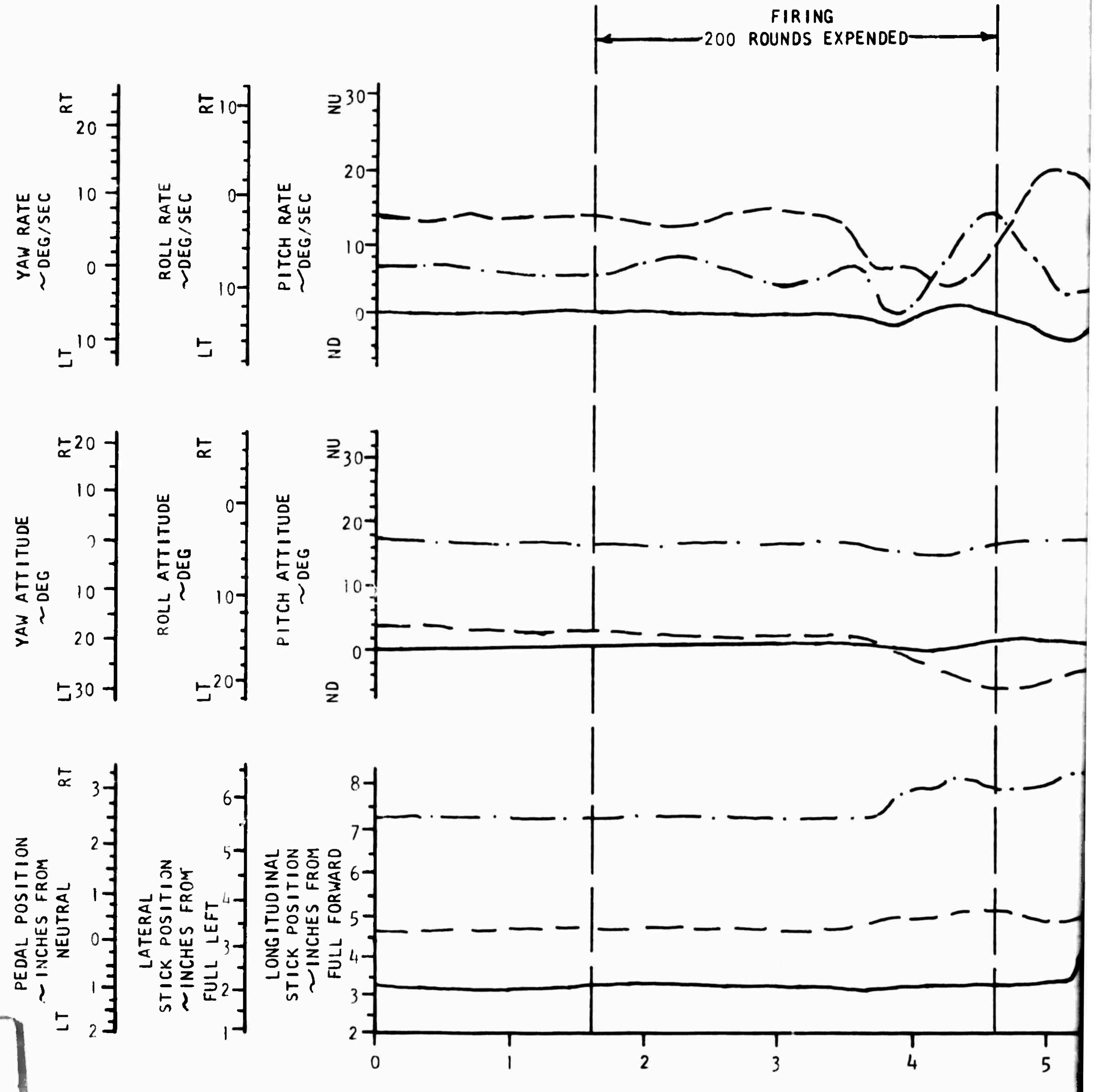
53

2

FIGURE NO. 41
XM-27-E1 WEAPON FIRING
OH-6A S/N 65-12967
LEFT SIDESLIP FLIGHT

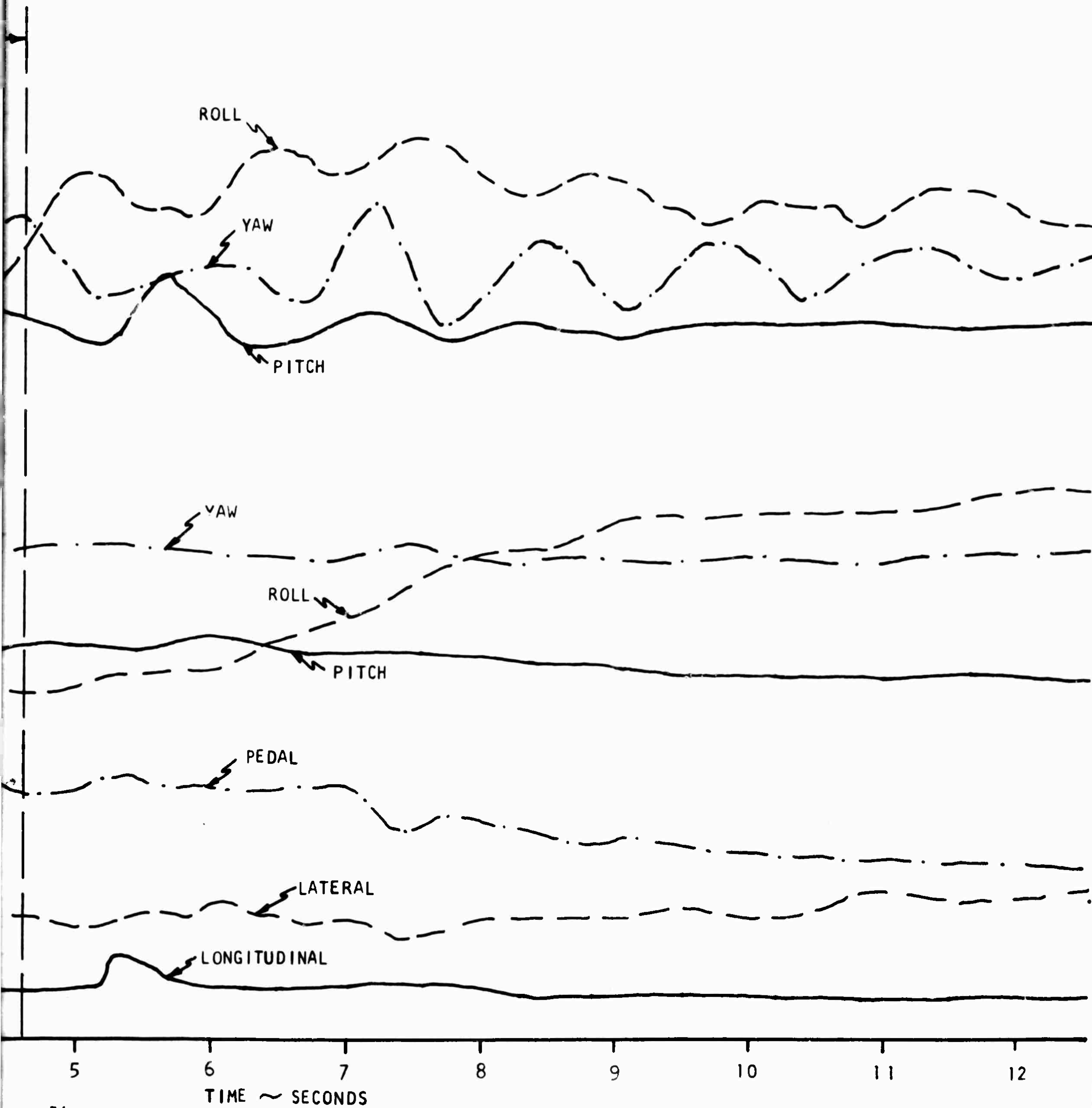
TRIM AIRSPEED = 110 KCAS
DENSITY ALTITUDE = 3610 FT.
C.G. LOCATION = Sta. 97.1 (FWD)

GROS
ROTO
GUN



NO. 41
PON FIRING
65-12967
IP FLIGHT

GROSS WEIGHT = 2400 LB.
ROTOR SPEED = 483 RPM
GUN ELEVATED



2

FIGURE NO. 42
AIRSPEED CALIBRATION
OH-6A S/N 65-12919
STANDARD SYSTEM
CLEAN CONFIGURATION

DENSITY ALTITUDE FT	GROSS WEIGHT LB	ROTOR SPEED RPM	C.G. LOCATION IN	FLIGHT CONDITION
3540	2120	483	100.0 (Mid)	Level Flight

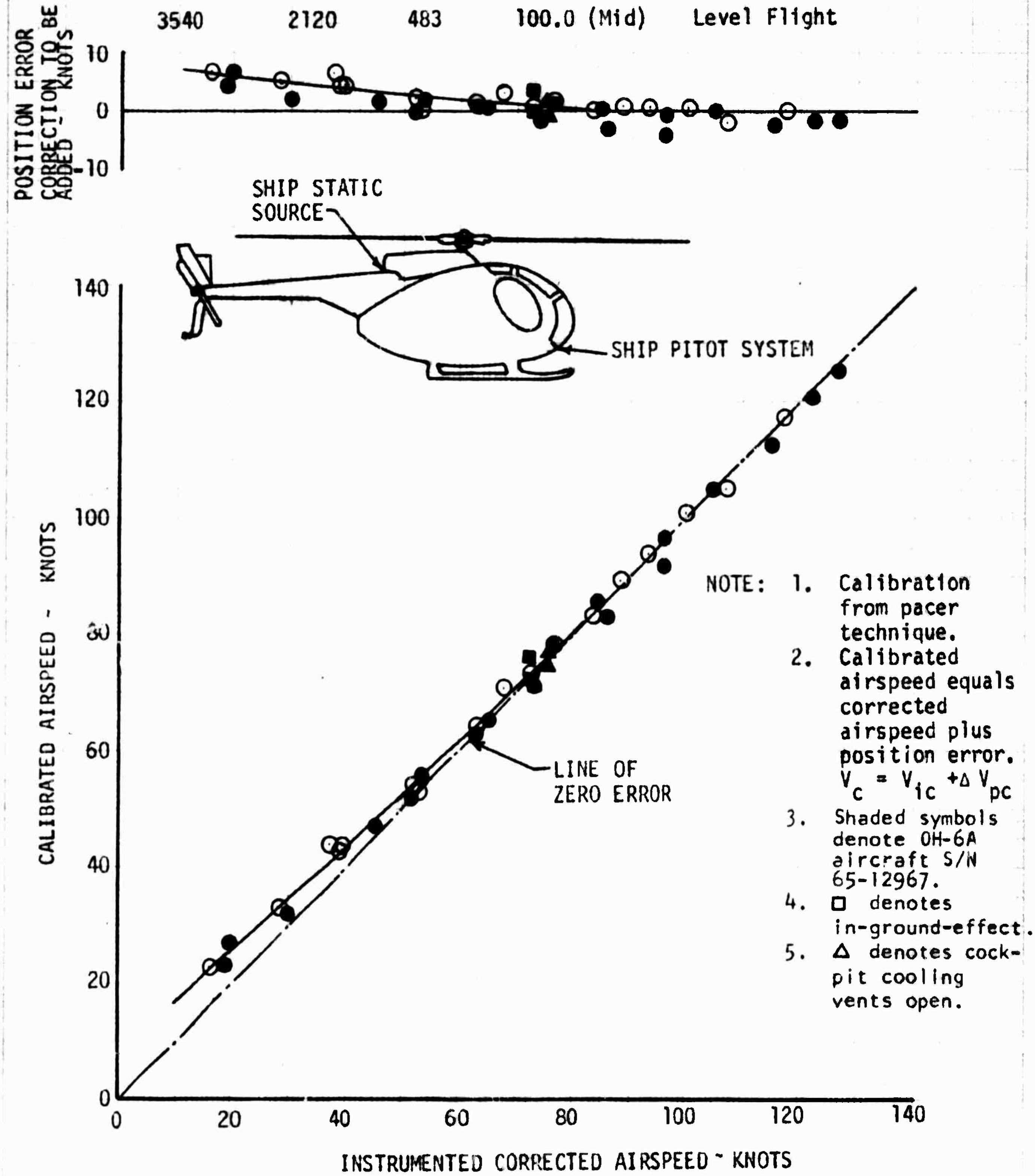


FIGURE NO. 43
INLET PERFORMANCE
OH-6A S/N 65-12919

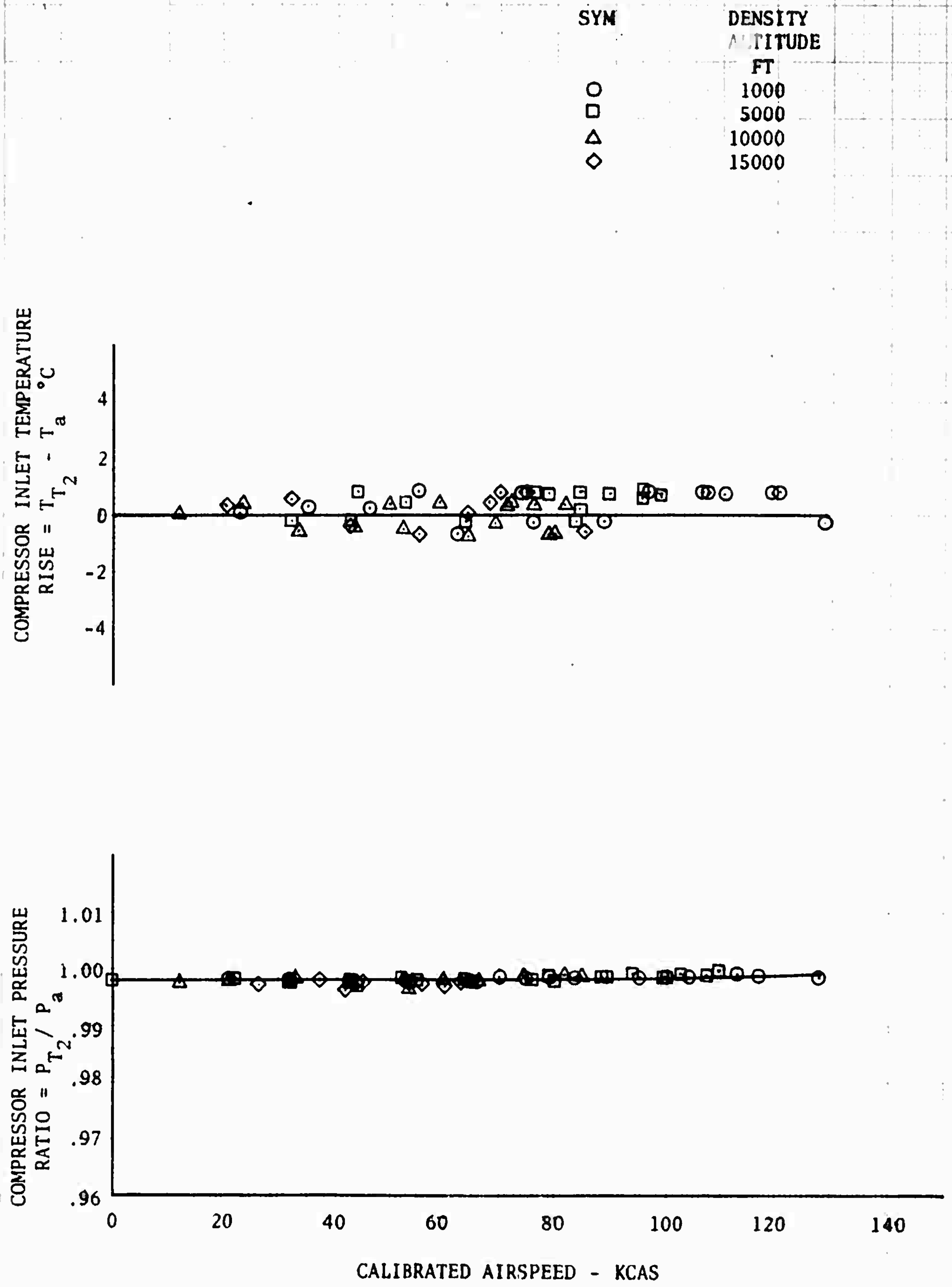


FIGURE NO. 44
ENGINE CHARACTERISTICS
T63-A-5A

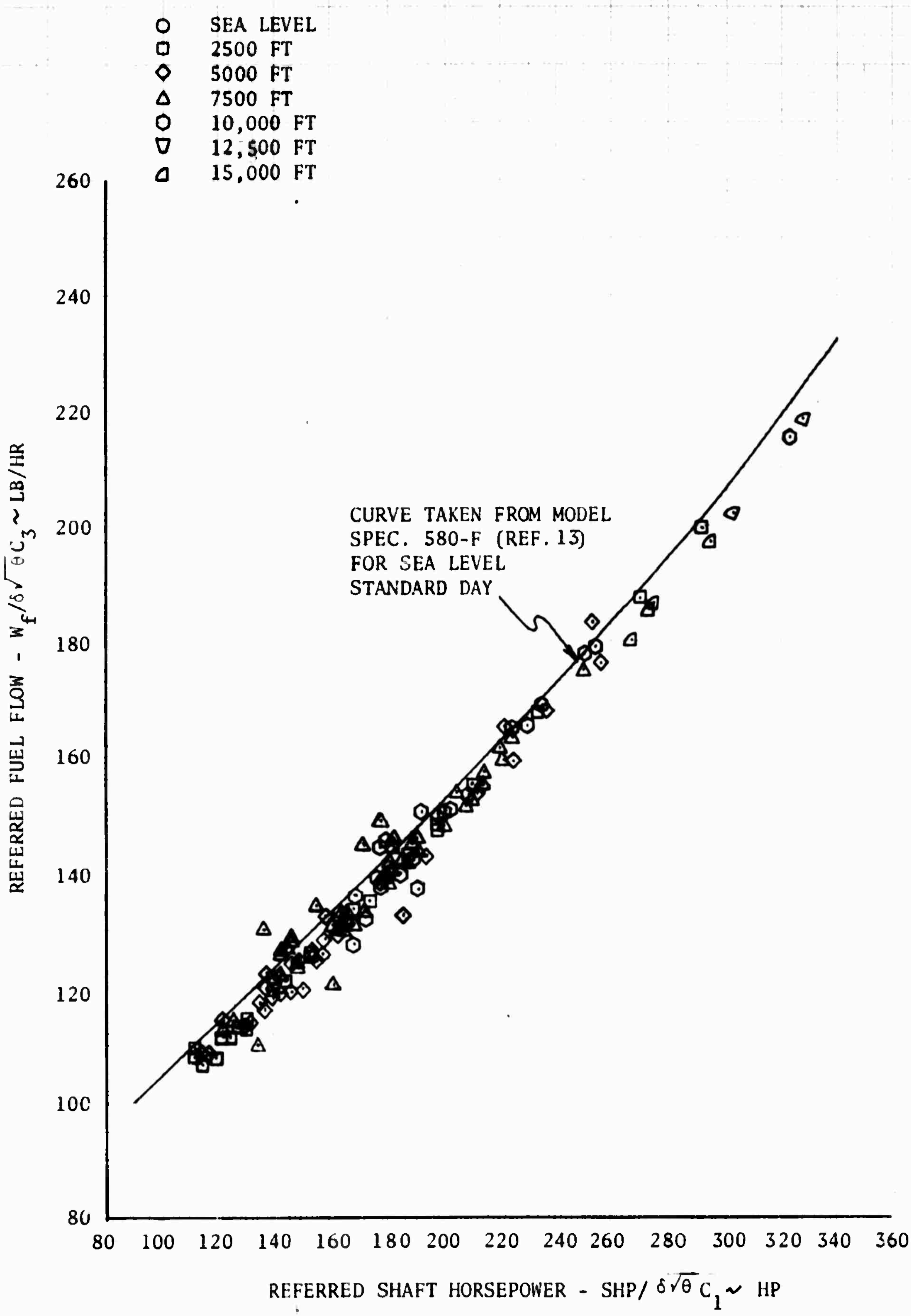


FIGURE NO. 45
SHAFT HORSEPOWER AVAILABLE
OH-6A S/N 65-12967

TAKEOFF POWER

$T_{T_5} = 749°C$

$N_2 = 103\%$

NOTES:

1. Based on compressor inlet condition as defined in Figure 43 at zero airspeed..
2. Shaft horsepower derived from Engine Model Specification 580-F. (REF 13)
3. Power extracted equals 1.2 SHP.

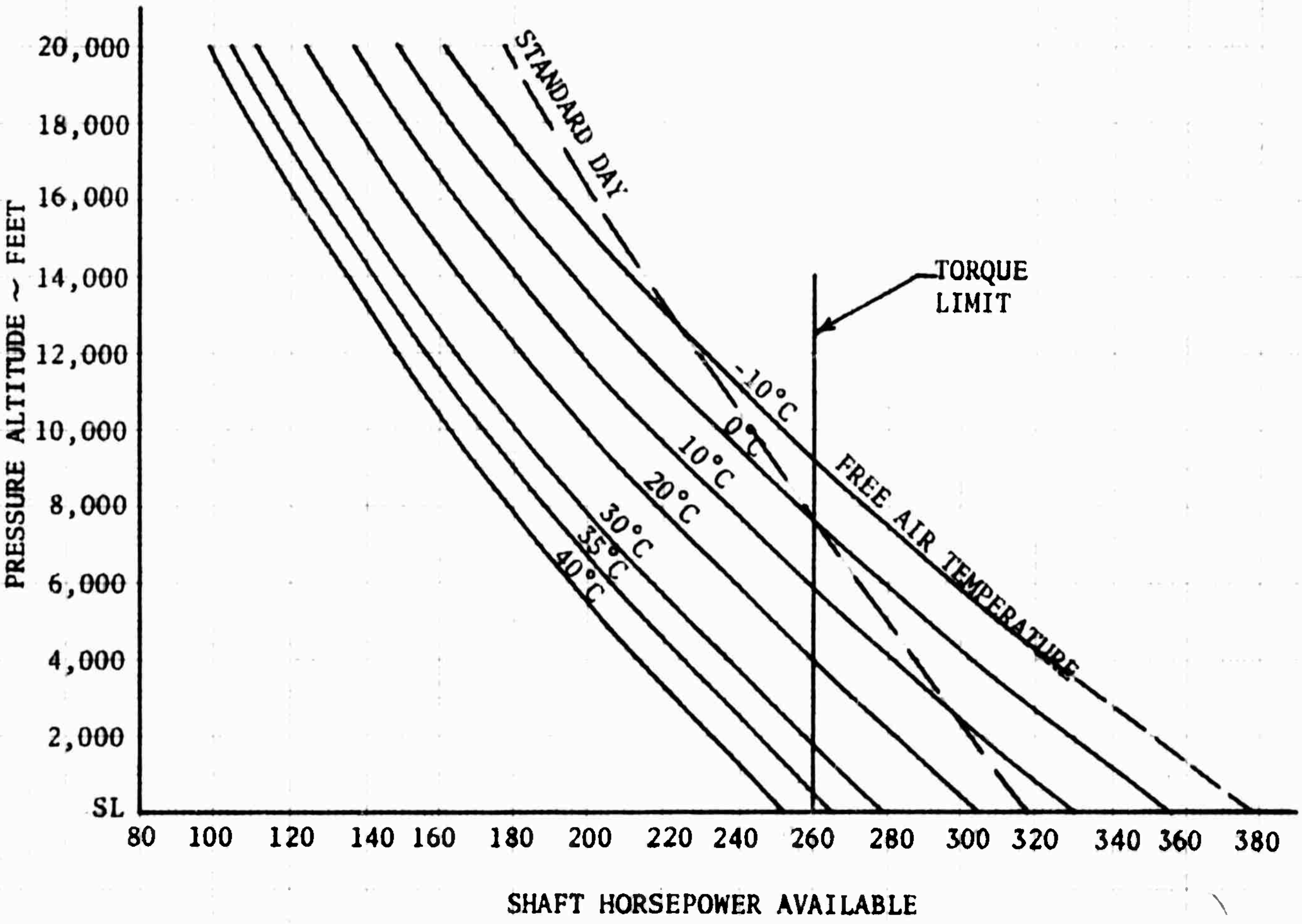


FIGURE NO.46

SHAFT HORSEPOWER AVAILABLE

OH-6A S/N 65-12967

MAXIMUM CONTINUOUS POWER

$T_{T_S} = 693°C$

$N_2 = 103\%$

NOTES:

1. Based on compressor inlet condition as defined in Figure 43 at zero airspeed.
2. Shaft horsepower derived from Engine Model Specification 580-F. (REF 13)
3. Power extracted equals 1.2 SHP.

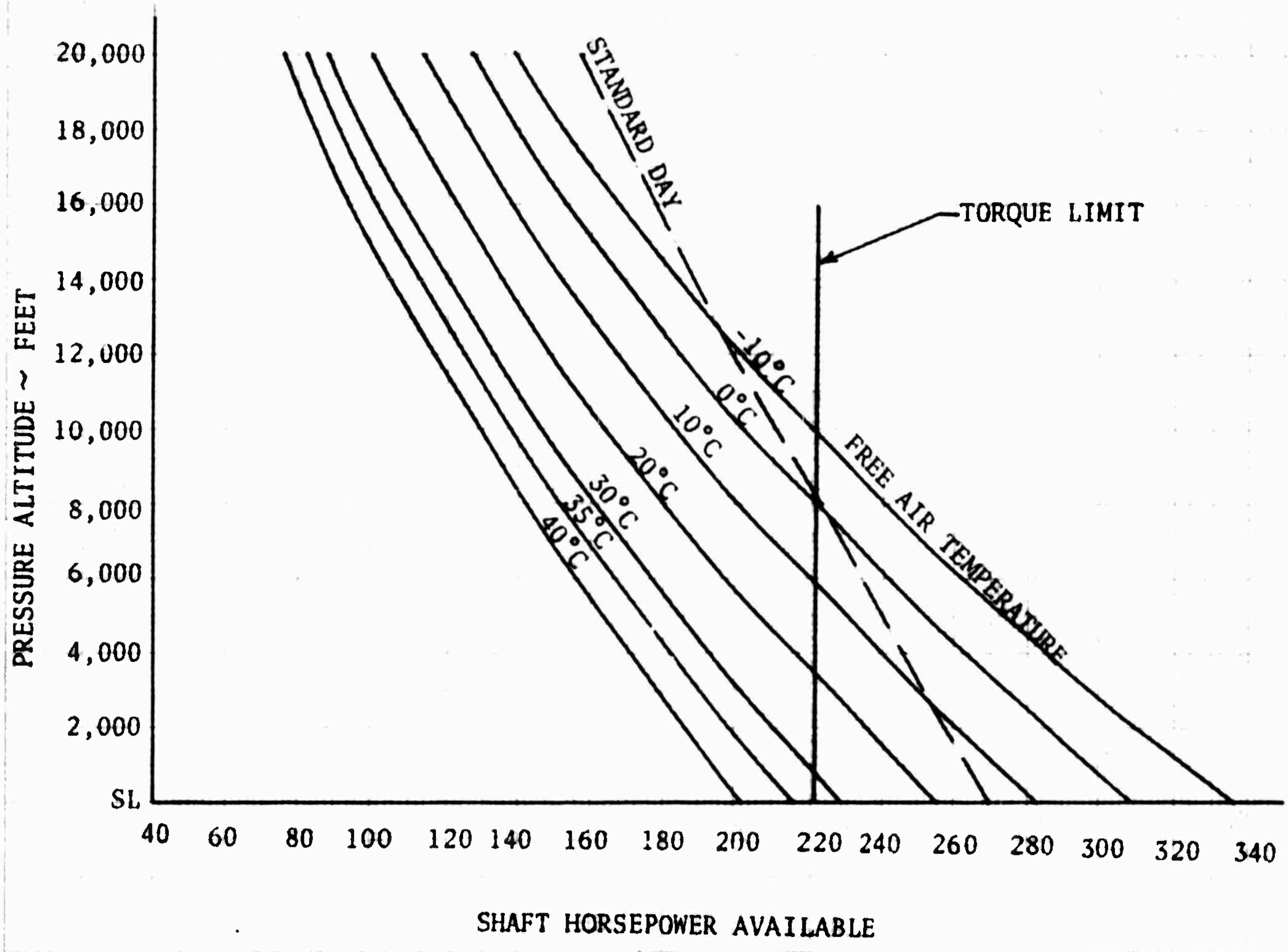
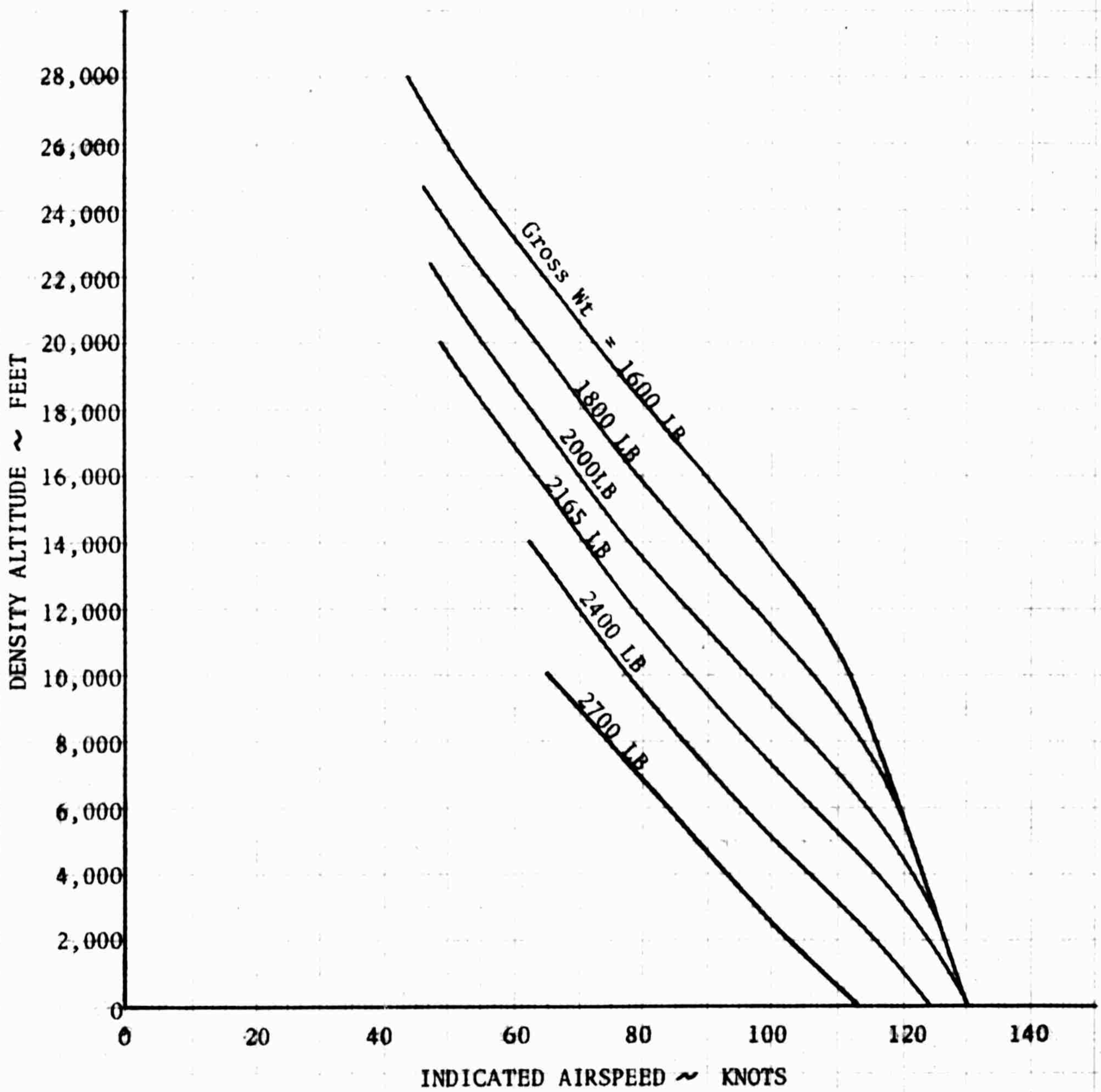


FIGURE NO. 47
GENERAL FLIGHT ENVELOPE
OH-6A
T63-A-5A ENGINE
483 ROTOR RPM



APPENDIX III

<table>
<tr><td rowspan="9">CONTROLLABLE
CAPABLE OF BEING CONTROLLED OR MANAGED IN CONTEXT OF MISSION, WITH AVAILABLE PILOT ATTENTION</td><td rowspan="6">ACCEPTABLE
MAY HAVE DEFICIENCIES WHICH WARRANT IMPROVEMENT, BUT ADEQUATE FOR MISSION.
PILOT COMPENSATION, IF REQUIRED TO ACHIEVE ACCEPTABLE PERFORMANCE, IS FEASIBLE.</td><td rowspan="3">SATISFACTORY
MEETS ALL REQUIREMENTS AND EXPECTATIONS, GOOD ENOUGH WITHOUT IMPROVEMENT
CLEARLY ADEQUATE FOR MISSION.</td><td>EXCELLENT, HIGHLY DESIRABLE</td><td>A1</td></tr>
<tr><td>GOOD, PLEASANT, WELL BEHAVED</td><td>A2</td></tr>
<tr><td>FAIR. SOME MILDLY UNPLEASANT CHARACTERISTICS. GOOD ENOUGH FOR MISSION WITHOUT IMPROVEMENT.</td><td>A3</td></tr>
<tr><td rowspan="3">UNSATISFACTORY
RELUCTANTLY ACCEPTABLE. DEFICIENCIES WHICH WARRANT IMPROVEMENT. PERFORMANCE ADEQUATE FOR MISSION WITH FEASIBLE PILOT COMPENSATION.</td><td>SOME MINOR BUT ANNOYING DEFICIENCIES. IMPROVEMENT IS REQUESTED. EFFECT ON PERFORMANCE IS EASILY COMPENSATED FOR BY PILOT.</td><td>A4</td></tr>
<tr><td>MODERATELY OBJECTIONABLE DEFICIENCIES. IMPROVEMENT IS NEEDED. REASONABLE PERFORMANCE REQUIRES CONSIDERABLE PILOT COMPENSATION.</td><td>A5</td></tr>
<tr><td>VERY OBJECTIONABLE DEFICIENCIES. MAJOR IMPROVEMENTS ARE NEEDED. REQUIRES BEST AVAILABLE PILOT COMPENSATION TO ACHIEVE ACCEPTABLE PERFORMANCE.</td><td>A6</td></tr>
<tr><td rowspan="3">UNACCEPTABLE
DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT. INADEQUATE PERFORMANCE FOR MISSION EVEN WITH MAXIMUM FEASIBLE PILOT COMPENSATION.</td><td rowspan="3"></td><td>MAJOR DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT FOR ACCEPTANCE. CONTROLLABLE. PERFORMANCE INADEQUATE FOR MISSION, OR PILOT COMPENSATION REQUIRED FOR MINIMUM ACCEPTABLE PERFORMANCE IN MISSION IS TOO HIGH.</td><td>U7</td></tr>
<tr><td>CONTROLLABLE WITH DIFFICULTY. REQUIRES SUBSTANTIAL PILOT SKILL AND ATTENTION TO RETAIN CONTROL AND CONTINUE MISSION.</td><td>U8</td></tr>
<tr><td>MARGINALLY CONTROLLABLE IN MISSION. REQUIRES MAXIMUM AVAILABLE PILOT SKILL AND ATTENTION TO RETAIN CONTROL.</td><td>U9</td></tr>
<tr><td colspan="3">UNCONTROLLABLE
CONTROL WILL BE LOST DURING SOME PORTION OF MISSION.</td><td>UNCONTROLLABLE IN MISSION.</td><td>10</td></tr>
</table>

Revised Pilot Rating Scale

APPENDIX IV

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3. REPORT TITLE

ENGINEERING FLIGHT TEST (PRODUCT IMPROVEMENT TEST) OF PRODUCTION OH-6A HELICOPTER UNARMED AND ARMED WITH THE XM-27E1 WEAPON SYSTEM, PHASE D.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report 27 June 1967 - 24 October 1967

5. AUTHOR(S) (First name, middle initial, last name)

John I. Nagata, Project Engineer
Herman P. Wolf, Engineer
John J. Shapley, Project Pilot

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
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8a. CONTRACT OR GRANT NO. b. PROJECT NO. USATECOM 4-4-1601-06 c. 4-6-0250-01 d.	9a. ORIGINATOR'S REPORT NUMBER(S) USAAVNTA Project No. 65-37 65-41 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) N/A

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13. ABSTRACT

An engineering flight test of the OH-6A helicopter equipped with the XM-27E1 armament subsystem was conducted at Edwards Air Force Base, California, by the US Army Aviation Test Activity (USAAVNTA). The objective of the test was to determine what effects the armament subsystem had on the performance and stability and control characteristics as compared with an aircraft without the armament subsystem. The testing consisted of 10.25 productive test hours and was conducted from 2 October 1967 through 24 October 1967. Performance degradation resulted from the drag imposed by the armament subsystem. The specific range at 2400 pounds gross weight decreased by 8 percent. The stability and control characteristics were essentially unchanged by the addition of the armament subsystem. During firing tests, there were no adverse control problems. However, during flight at 12 degrees left sideslip at 105 knots indicated airspeed (KIAS), the upper right windshield imploded. The sideslip angle should be limited to 8 degrees or less at 100 KIAS until the cause of the implosion can be determined. Noise level and vibration tests should be conducted during firing with the "doors off" configuration. The performance data should be incorporated into the Operator's Manual.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
OH-6A Helicopter XM-27E1 Weapon System Engineering flight test Product Improvement Test Performance degradation Gross weight Stability and control						

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